POWER

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ELY C. HUTCHINSON, *Editor*

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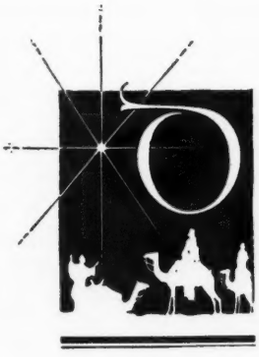
MERRY CHRISTMAS



ONCE AGAIN I am privileged to wish the friends and patrons of Power, on behalf of those who are devoted to their service, a Merry Christmas and a Happy New Year. ▱▱ To one and all we wish an abundance of the cheer that goes with this holiday season. ▱▱ For the little ones it is the day of days when one really makes believe and the legendry and trappings are as gospel and cloth of gold. ▱▱ And for those who are older, there is the seasonally inspired thought of the needs and happiness of others and, this year, the added satisfaction of giving help in circumstances which manifest the brotherhood of man as never before. ▱▱ So we achieve on earth the Peace and Good Will Toward Men which combine with the customs of the season to make the Christmas festival. ▱▱ May your anticipations and those depending upon you for their realization be abundantly fulfilled and may the impressions and the memories connected with this season be a source of continual gratification to you. ▱▱ Of such fragments is a contented mind composed.

F. R. LOW

EDITORIALS

A Vulnerable Precedent

Block plants while not as numerous as formerly are nevertheless to be found in many cities supplying steam and electricity to groups of buildings. Usually the arrangement is economical because of minimum transmission losses and favorable diversity in demand. Except in isolated cases where the buildings are under common ownership, use of the city streets is not involved and there is no conflict with the franchises of the local utility.

A somewhat different case, and one that is attracting wide attention, is the Springler-Van Buren Estate in New York City. This party owns considerable property in the Union Square district and has just been granted a franchise by the Board of Estimate to use the city streets not only to supply electricity to its own tenants, but also to any other customer along its lines who may desire service. Before the franchise can become effective a certificate of convenience and necessity must be obtained from the Public Service Commission.

Whatever may be said as to the motives of the Mayor and the city board, the action involves a precedent that may extend beyond the scope of this particular case and threaten the public utility structure.

It is doubtful that the Public Service Commission will grant the application. If it refuses, the existing breach between that body and the Board of Estimate will be widened and the rate situation will be further agitated. If it accedes to the request there is no telling where further development of this principle will lead.

A Forward Step For Industry

In a speech before the annual meeting of the American Society of Mechanical Engineers, J. W. Hook classified the present unemployed into three general groups according to their worker-value to industry. This, together with his views concerning the responsibility of industry toward these groups, presents an arresting viewpoint of this oft-discussed subject.

Mr. Hook estimates about twenty-five per cent of those unemployed to be unemployable, physically or mentally unfitted to industry's needs. The size of this group as estimated by him is astounding, since they constitute a burden on productive labor and accumulated wealth alike.

The nomadic workers are estimated at thirty-five per cent of the unemployed. Migrating from job to job and from industry to industry, they fill industry's seasonal and periodic variations. Mr. Hook states that these workers neither desire nor are able to hold permanent jobs. One cannot help but feel that a large number of this group are victims of the inefficiency of the economic machine. Lacking the opportunity to become part of the base-load capacity of any particular industry, they work when and where they can.

The remaining forty per cent unemployed Mr. Hook estimates to be stable and capable workers who have stuck to the job as long as the job stuck to them. To this group individual employers have a direct responsibility, and it is his opinion that reserves should be set up in full years to carry over the slack periods, such reserves to be considered a legitimate charge against revenues.

A general recognition by industry of such a responsibility for this third group alone would be a tremendous forward step in the direction of economic stabilization. Efforts along this line are of material practical advantage. The ultimate solution, however, must take cognizance likewise of industry's responsibilities toward the other two groups.

The second, the nomads, may well be considered a result of the fluctuations, the variable operating rate of the industrial machine. As purchasing power is progressively stabilized through more equitable distribution of the wealth produced by industry, greater numbers of this second group will be enabled to join the third, the stable workers.

Responsibility for Elevator Accidents

Complaint is often made that it is difficult to protect persons from injury who will not try to take care of themselves. This is true, but despite much that has been done to prevent industrial and other accidents many hazardous conditions are permitted that could be easily eliminated.

A case in point is the hazards that exist at elevator landing doors in many states. In New York State, according to *The Industrial Bulletin,* one hundred and eighty-two persons employed in various industries fell down elevator hoistways in the year June 1929 to 1930. Other states have elevator accident records comparable to these.

Experience has shown that from seventy-five to ninety per cent of all elevator accidents occur at landings and can be prevented by installing proper safety devices. In states where it is mandatory that elevator landing and car doors be interlocked with the control, serious accidents at these locations are practically unknown. While complete elimination of elevator accidents is beyond attainment, reasonable protection should closely approach the ideal in preventing injury.

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POWER Stands for . .

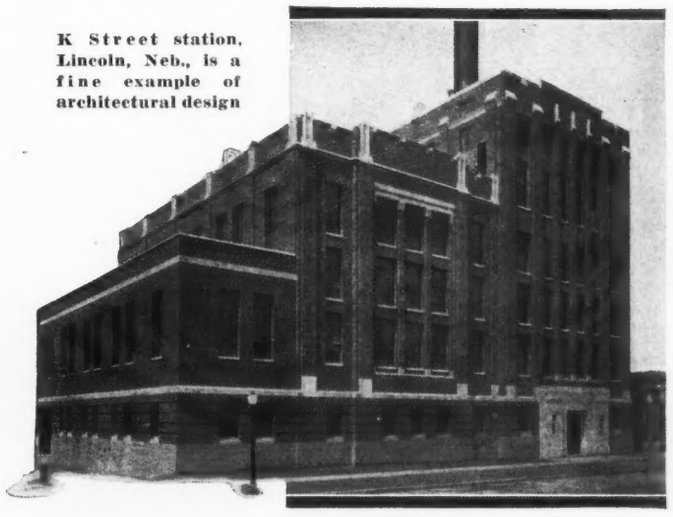
1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

LINCOLN'S

New Generating Plant Bleeds Steam for

District Heating and Process

An economical 12,000-kw. plant housed in modern artistic building, built for $110 per kilowatt. Economizers, air preheaters and stage heating of feed water contribute to an over-all boiler plant efficiency of 86 per cent. Steam for district heating and for process in a creamery is bled from the main turbine-generators. Other features of interest are hydraulic ash sluicing, treatment of the salty water supply, and precautions taken to guard against galvanic action in equipment coming in contact with salty condenser cooling water



K Street station, Lincoln, Neb., is a fine example of architectural design

IN 1924 the United Light & Power Company acquired in Nebraska and western Iowa the properties of the Continental Gas & Electric Company, consisting of numerous small water-power and steam plants and certain transmission lines. Immediate steps were taken to enlarge and develop the system into a property now containing 2,300 miles of transmission lines interconnecting plants totalling 51,000 kw. in generating capacity. Out of this total capacity 17,000 kw. is in modern high-economy steam equipment, 2,000 kw. in diesel engines, and the balance in small steam and water plants. Where economically feasible the small steam plants are operated non-condensing so that they may exhaust into district heating systems. The plan is in line with the present trend toward decentralization to recover byproduct power from process steam. Using the heating systems as condensers for power units proves highly economical during the heating season. For the balance of the year the plants are not used except for occasional peak or emergency service, and local power is drawn from the transmission line supplied by the more economical generating stations and an interconnection with the Nebraska Power Company at Omaha.

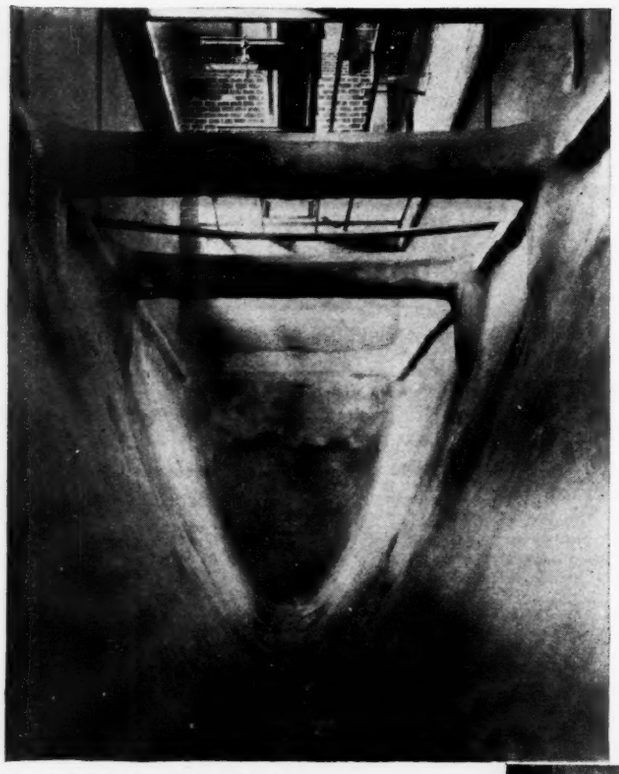
At Lincoln, Neb., the largest city on the system, there were originally two plants, one serving the traction system and the other supplying light and power. The former had a 4,000-kw. condensing turbine-generator arranged for extraction to the heating main serving the business section of the city, and a 1,500-kw. machine exhausting directly to the heating system. The primary steam pressure was 160 lb. The lighting plant, with an aggregate capacity of 9,500 kw. in three condensing turbine units, operated on a steam pressure of 225 pounds.

An interconnection with the railway plant for the interchange of 5,000 kw. delayed the necessity for additional capacity until 1928. By this time the district peak, by exceeding 12,000 kw., had reached the limit in capacity of the most economical units in the two plants, leaving no reserve other than the service transmitted from Omaha, which was good for 2,500 kw. This shortage of capacity to meet the district peak, high production cost, the obsolete and inefficient equipment in the traction plant, and the need for additional capacity to expand the steam heating system, brought about the decision to install a new plant that would not only supply the electric and heating requirements of Lincoln, but also supply the 2,300-mile transmission system.

Basic electric and steam loads projected ahead for six years indicated a local peak of 15,000 kw. by 1934, a steam heating load averaging 31,700 lb. per hour during the season, with the peak reaching 120,000 lb., and a creamery service requiring 6,600 to 10,000 lb. of steam per hour for process.

Consideration of generating cost and overhead in five plans, differing in plant location, size and number of units, and the question of building new or adding to present facilities, led to the installation of the new station adjacent to the old railway plant.

Units of 6,000 kw. capacity were the logical size for the load. Turbines of the automatic bleeder condensing type were selected to supply the heating and creamery loads. Individual steam-generating capacities of 140,-



Concrete-lined overhead bunker

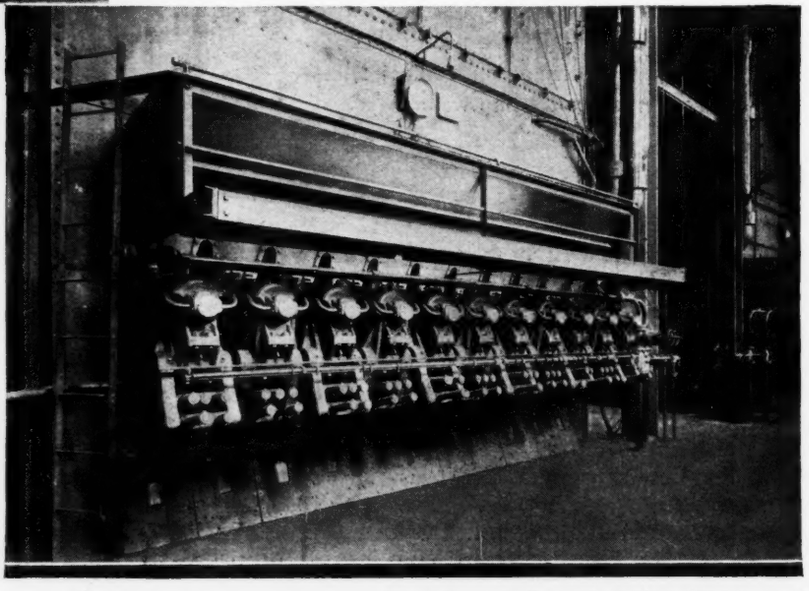
000 lb. per hour permitted the use of one boiler per turbine. Steam pressures of 400 to 600 lb. were considered, but dollar economy pointed to the use of the higher pressure. Estimates on definite loads, taking into account the steam bled for heating and process, indicated a saving of $12,500 per year, which capitalized at the usual rate more than offset a 20 per cent differential, amounting to $7 per kilowatt in the cost of the pressure parts in the boilers, turbines, auxiliaries and piping.

Bleeding 6,000 to 10,000 lb. of steam at 125 lb. gage for the creamery load was another factor making 600 lb. pressure more desirable. Incidentally, the size of the unit also was a determining factor. Units for a throttle pressure of 400 lb. and 700 deg. F. total temperature came in standardized sizes stepping from 5,000 to 7,500 kw. An intermediate size better suited to the load conditions would have had to be built special. For 550 lb. and 725 deg. F. at the throttle these limitations did not exist, as machines of the size were more or less special and could be built for any desired rating. Arrangements also were made for a generator rated for 6,000 kw. at 70 per cent power factor, to give additional capacity when the system power factor exceeds the foregoing figure.

The boiler plant design was carried through for an over-all efficiency of 86 per cent, involving the use of economizers, air preheaters and stage heating of the feed water. Location of the plant between business and residential districts made the elimination of smoke, cinders and fly ash imperative. This factor influenced the installation of underfeed stokers with cinder catchers in the uptakes to a stack rising 204 ft. above grade. The location also called for a building of modern artistic design. Exclusive of real estate, the cost per kilowatt of rating, based for comparison on 80 per cent power factor, or 13,700 kw., was held to approximately $110, a figure that is remarkably low considering the small capacity of the plant, the steam pressure used, the increased boiler capacity to furnish process steam, and the refinement in design necessary to insure high economy.

Regardless of the money spent to contribute to the appearance of the plant, both inside and out, the building construction has been economical, owing to compact layout, full utilization of the space, use of the building steel to support plant equipment, stack and overhead bunker, and simultaneous installation of boiler room equipment along with the erection of the building. A large guyed derrick set at the elevation of the economizer floor to handle the building steel was used to erect practically all boiler room equipment and air ducts, except the boiler drums. Owing to their weight, these drums were hoisted from the building steelwork with block and tackle. The derrick also contributed to the erection of the turbine room crane, so that it might be available to handle the main units and auxiliaries.

A contribution to space conservation was the concentration of plant accessories, such as offices, laboratory, wash rooms, storage space, stairways and elevator giving access to all main floors of the building, in a definite section limited in floor plan by the space allotted to the main entrance lobby. Another feature was the use of an 18-in. reinforced concrete mat under the entire structure. Resting on a sand and clay base, this mat eliminated the need of separate footings for columns and equipment, and lifted the construction work out of the mud.



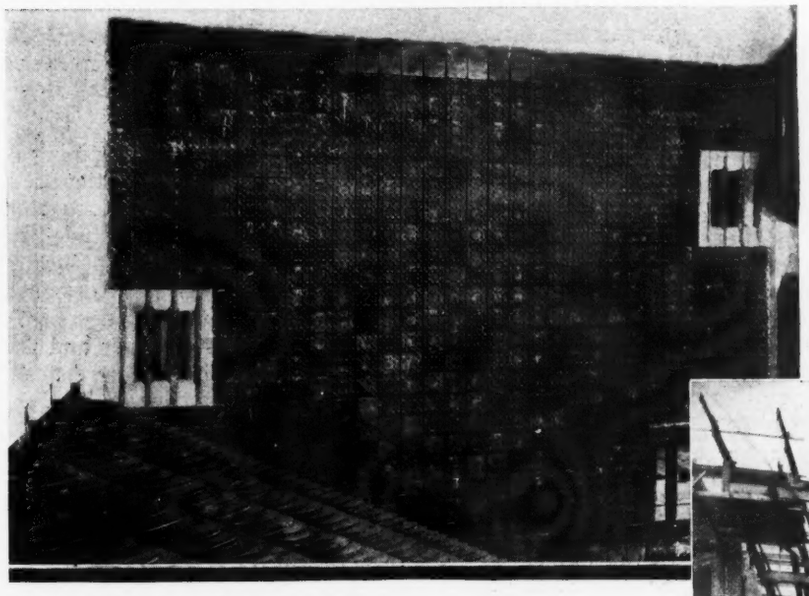
Cross-drum boilers equipped with 11-retort hydraulically operated underfeed stokers

The vertical arrangement of equipment in the boiler room called for a minimum of ground area but required a building rising approximately 80 ft. above grade. A unit layout of one boiler per turbine was arranged. With 10,506 sq.ft. of heating surface, each boiler has a maximum steaming capacity of 140,000 lb. per hour delivered at an operating pressure of 600 lb. and a total steam tem-

perature of 740 deg. F. at the superheater outlet. To give a flat curve over the entire range of operation, combination convection and radiant superheaters are used. The maximum heat release is figured at 33,800 B.t.u. per cubic foot. The furnace side walls and the lower portion of the rear wall are lined with cast-iron armored-type water-cooling surface aggregating 727 sq.ft. Through external headers this surface connects into the boiler circulation.

Hydraulically operated 11-retort underfeed stokers 41 tuyères long burn strip-mine coal from Kansas, principally from the Cherokee seam. Fine ash sifting through the grates is chuted directly to a hydrojet ash-sluicing system. Clinkers pass through double-roll grinders into a firebrick-lined pit having capacity for eight hours' continuous run. From the inclined floor of the hopper the clinkers and ash are washed by oscillating nozzles into a sluiceway running to a storage pit outside the building. Propelling jets in the sluiceway at every change in direction and every 20 ft. on the straightway maintain the flow. A trolley hoist equipped with a grab bucket transfers the ash to railway cars through a grinder provided to size the clinker for ballast.

Vertical screen filters, first used in the pit to separate the water for recirculation, gave trouble by clogging. The construction was changed to permit the use of horizontal filters, with a nozzle playing on the under side of the screen to help clear out floating carbon particles.



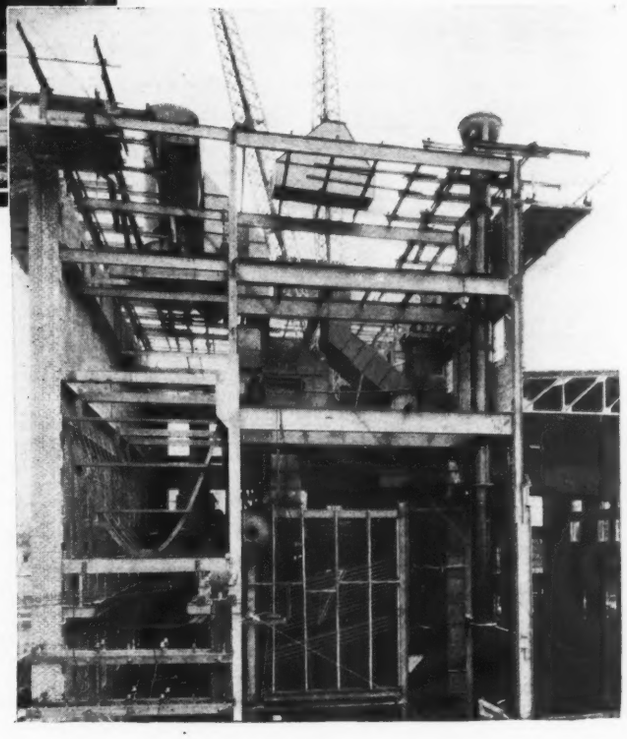
Interior of furnace, showing cast-iron armored-type water walls

As much of the steam passing from the main turbines is bled for heating and process use in the creamery, so that only low-stage bleeding and auxiliary exhaust in the open heater are available to heat the feed water, a counterflow economizer of relatively small size has been inserted in the cycle to raise the feed temperature from 212 to 300 degrees. Maximum recovery of heat from the flue gases called for an air preheater of large proportions that would give a maximum air temperature of 350 deg. and reduce the gas temperature to approximately 250. A tempering damper provides for control of the air temperature. One of the factors entering into the selection of a preheater of the regenerative counterflow type was the low headroom requirement that made it possible to install both economizer and heater at the same elevation and still leave room on the floor above for the forced-draft as well as the induced-draft fans. The induced-draft fans are in close proximity to the self-supporting lined steel stack rising 120 ft. above the roof. Between fans and stack the interconnecting breechings on the roof contain the cinder traps.

Outdoor space to store 10,000 tons of coal was available in the block across from the plant. Here bottom dump cars switched by an electric locomotive deliver to a track hopper. Plate feeders transfer the coal to a hammer crusher or directly to a 20-in. belt conveyor 342 ft. long running underground through a tunnel to the plant. A bucket elevator rising 97 ft. to the top of the boiler house spouts the coal to a scraper conveyor running over the bunker. Gates in the trough, spaced uniformly every 4 ft., are opened according to the distribution desired. The parabolic steel bunker of 504 tons' capacity is lined with concrete, applied with a gun to a thickness tapering from 6 in. at the bottom to 3 in. at the top. A 6-ton traveling weigh larry delivers the coal to the stoker hoppers.

Quality of the city water available and the large amount of non-returnable condensate, requiring at times as high as 80 per cent makeup, complicated the boiler-feed problem. As taken from the wells, the water contains about 12 gr. per gallon of scale-forming matter and, as the ground is underlain with salt, from 1½ to 6 gr. of sodium chloride. As the salt cannot be removed by treatment, blowdown up to 15 per cent of the water evaporated is necessary to prevent concentration in the boiler in excess of 250 to 300 gr. per gallon. Owing to this liberal blowdown, no trouble has been experienced from pitting. Conservation of the heat in the water made

Erecting boiler-room equipment with derrick used for building steelwork

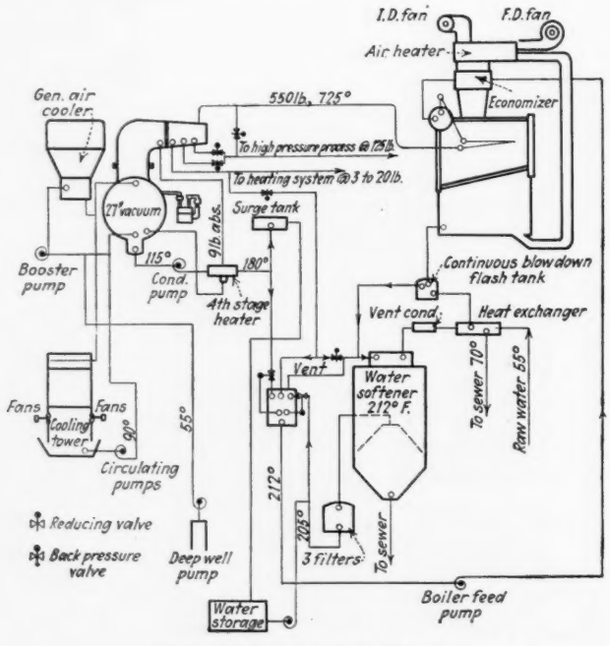


desirable the installation of a continuous blowdown system into which a flash tank has been interjected that immediately flashes 30 per cent of the blowdown into steam, which is delivered to the open heater on the water softener. The balance of the blowdown passes through the heat exchanger, giving up its heat to the incoming make-up water, to be discharged finally to the sewer at a temperature approximating 75 degrees.

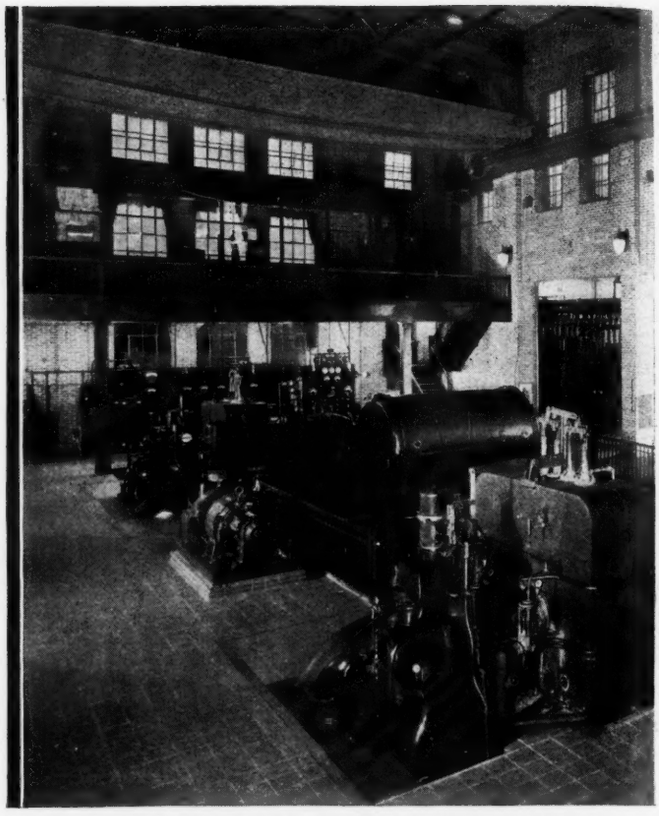
Treatment is effected in a hot-process system using lime and soda ash, and, as a final precaution, phosphate in the open heater to remove any bicarbonate remaining in the water. Introduced in sufficient quantity so that some excess always remains in the boiler water, the phosphate is also a safeguard against caustic embrittlement. Checks on phosphate, alkalinity and concentration, made every hour, indicate any change in treatment that may be necessary.

Raw water is passed to a sedimentation tank to be treated and heated to 215 deg. by the steam flashed from blowdown and steam bled from the turbine. Through gravel pressure filters the water enters the open feedwater heater, which, being of the thoroughfare type, tends to eliminate the CO_2 and oxygen that have not been removed in the softener. Condensate from the main condensers in amounts varying with the steam bled from the turbine is also collected in the heater after passing through the fourth-stage bleeder heater. The complete arrangement may be traced in the steam and water flow diagram.

Three boiler-feed pumps draw their suction from the open heater, two of 500 g.p.m. and one of 300 g.p.m. capacity. Constant-speed squirrel-cage motors drive two of the pumps and a steam turbine one of the larger units, so that the steam or electric drive may be alternated as required, one pump being large enough to supply the two boilers. Through separate lines, the pumps discharge to a ring header from which the feed passes through differential pressure regulators to the economizers, where the temperature rises to 300 deg. From each economizer the feed is through level regulators to each end of the boiler drum, the double feed being preferred, as the two valves give double assurance and better regulation than one larger valve.



Steam and water flow diagram

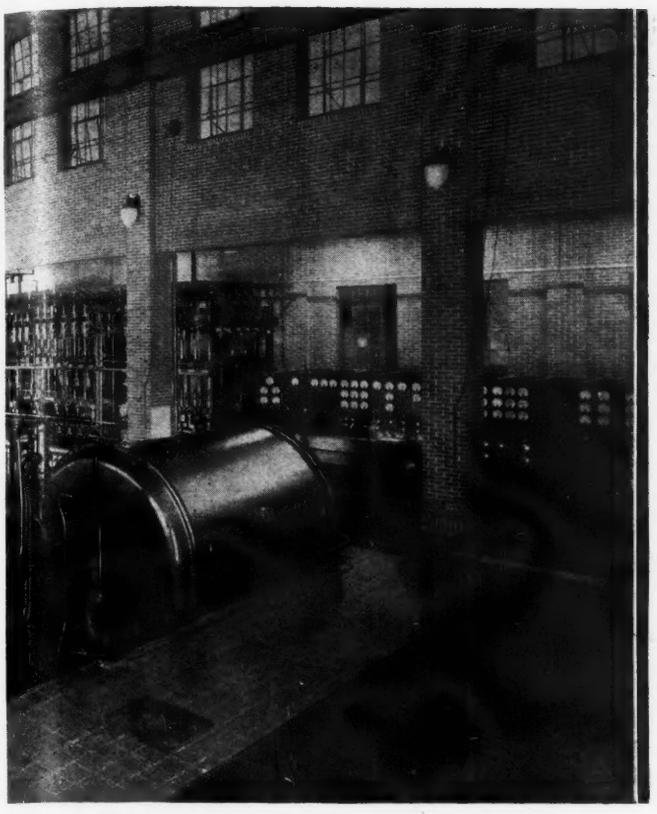


Two 6,000-kw. turbine-generators bled for district heating

Designed for 600 lb. working pressure, the piping is equipped with American standard fittings for the pressure, and large tongue-and-groove joints with corrugated monel metal gaskets and high-tension steel studs for bolting. To give minimum reaction on the superheater headers and turbine throttles, all bends were designed from special formulas developed by the engineers. A header of the welded type takes the two boiler and the two turbine leads. Insulation on the high-pressure steam piping consists of $1\frac{1}{2}$ in. of "Superex" covered by 2 in. of 85 per cent magnesia.

Combustion control is by hand from the central control on instrument panels at the operating floor. The fan motors and the pump motors on the stokers have push-button control. The instrument installation is complete, including the usual recording thermometers on gas, air and water, and steam-flow air-flow meters. To check the latter combination an orsat gas analyzer has been piped to the first pass of each boiler and equipped with an aspirator so that hourly readings can be taken.

An elaborate daily record system is in force. Curves of the electric load and the steam flow for the heating system are plotted. The daily averages of all essential operating data are entered on forms arranged for ten-day periods. From these records it has been possible to plot actual performance in the boiler room. Considering the fact that a coal inferior to that originally intended is being burned, the two sets of curves compare favorably, with the exception that the operating gas temperatures out of the boiler are considerably higher than anticipated. The economizer and air preheater, however, reduce the final gas temperature to that in the guaranteed performance. In the actual performance the effect of low CO_2 is in evidence. At a steam load of 40,000 lb. per hour, the over-all efficiency is 84.3 per cent, whereas the



and process steam compose present generating equipment

designed condition calls for 86 per cent. In both charts the latter figure is approximated at the normal steaming load of 90,000 lb. of steam per hour.

In the turbine room the two machines intended for the initial installation are in operation. Rated at 8,575 kva. and 70 per cent power factor, each unit has a 3-phase, 60-cycle, 4,150-volt generator with a 60-kw., 125-volt, direct-connected exciter. The speed is 3,600 r.p.m. As the plant is tied in on an extensive transmission system, it was considered desirable to provide equipment that would not create unusual telephone interference. At extra cost generator stators of $\frac{2}{3}$ pitch were provided to eliminate the triple harmonics that are so often objectionable to the telephone system.

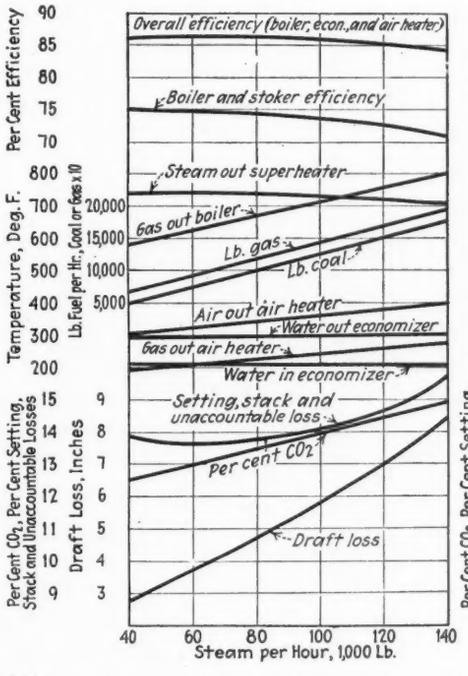
The turbine is a specially designed automatic four-point bleeder machine with two rows of impulse blades and 22 rows of reaction blades arranged for high economy, with 40 per cent of the throttle flow being extracted. With 550-lb., 725-deg. steam, and operating straight condensing at 27 in. vacuum, the turbine will develop 7,500 kw. From the first two bleeder points up to 10,000 lb. of steam per hour may be extracted for creamery process. Based upon a throttle flow of 51,000 to 135,000 lb., the pressure may range from 110 to 227 lb. abs. at the first point and from 83 to 193 lb. abs. at the second point. Although the present heating load averages 24,000 lb. per hour for the season, provision is made to meet an hourly demand of 120,000 lb. This steam is extracted from the third bleeder point at 3 to 20 lb. gage, while the fourth point supplies steam at 4 to 15 lb. abs. for feed-water heating.

Condensing equipment is standard, consisting of two-pass condensers arranged for radial steam flow, and the usual auxiliaries, including three circulating pumps, one turbine- and two motor-driven, for the two condensers, two motor-driven condensate pumps and two-stage steam-jet air pumps for each condenser.

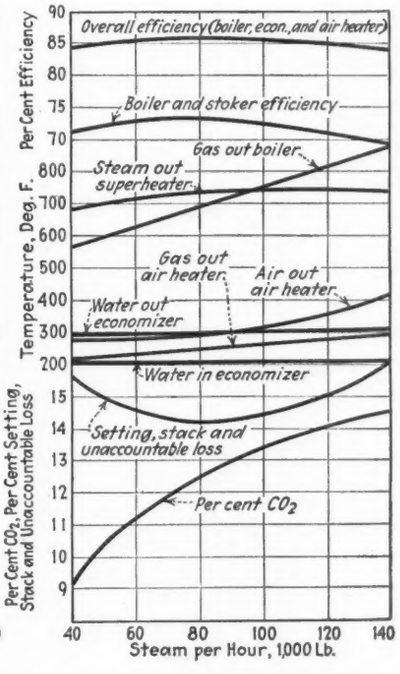
Use of salty cooling water enforced certain provisions to guard against scaling in the condenser tubes and galvanic action in all equipment through which the water passed. To minimize the expense for cooling water as well was sunk at the plant and a new cooling tower installed to conserve the supply. An existing natural-draft tower was rebuilt for forced draft, using sixteen 6-ft. propeller-type fans. With the installation of the second unit a new tower with ten 8-ft. fans was erected. Normal capacities are 9,000 and 7,500 g.p.m., respectively. Water from the well is circulated through the generator air and oil coolers, condensers of the steam-jet air pumps and through the main condensers before it is delivered to the distributing troughs of the towers.

As evaporation in the towers would soon give excessive concentration of salt that would tend to scale the condensers and coolers, provision was made to overflow the cooling tower basins into the sewer sufficiently to limit the concentration to twice that in the well. Pitting from galvanic action was guarded against by using metals of similar electro-chemical characteristics for the piping, valves, pumps and other equipment. For example, condenser cases were made of cast iron and the tubes of admiralty metal. Cast-iron valves bodies were provided with cast-iron disks and seats and stainless-steel silicon stems. Some trouble has been experienced with the valves, but otherwise there have been no noticeable effects from the use of this water.

In the electrical bay, running the full length of the


Per Cent Efficiency
Temperature, Deg. F.
Lb. Fuel per Hr., Coal or Gas x 10
Per Cent CO2, Per Cent Setting, Stack and Unaccountable Losses
Draft Loss, Inches
Overall efficiency (boiler, econ., and air heater)
Boiler and stoker efficiency
Steam out superheater
Gas out boiler
Lb. gas
Lb. coal
Air out air heater
Water out economizer
Gas out air heater
Water in economizer
Setting, stack and unaccountable loss
Per cent CO2
Draft loss
Steam per Hour, 1,000 Lb.

Designed boiler room performance from equipment guarantees


Per Cent Efficiency
Temperature, Deg. F.
Per Cent CO2, Per Cent Setting, Stack and Unaccountable Loss
Overall efficiency (boiler, econ., and air heater)
Boiler and stoker efficiency
Gas out boiler
Steam out superheater
Gas out air heater
Air out air heater
Water out economizer
Water in economizer
Setting, stack and unaccountable loss
Per cent CO2
Steam per Hour, 1,000 Lb.

Actual performance obtained in boiler room

turbine room, the bus structures and control boards have been arranged on three floors. At the turbine room level are the main 4,150-volt station buses and main circuit breakers, supported on pipe framework, and a steel-panel switchboard mounting the control, metering and protective equipment. On the floor below are the induction regulators for the lighting circuits. Each regulator is fed from a single-pole circuit-breaker, so that failure on any one phase will trip out only the specific phase involved.

In the basement are duplicate 4,150-volt house-service buses fed from the main buses through current-limiting reactors. All large house-service equipments, such as squirrel-cage motors designed for full-voltage starting and slip-ring motors with restarting control, are fed from these buses. Duplicate house-service buses for 460-volt service also are located on this floor to supply the smaller motors, the supply coming from the 4,150-volt house-service buses through step-down transformers. Two main feeds, one from each bus, go to the boiler room and two more to the turbine room. To them the various station auxiliaries are tapped through throwover switches at the motors. The transformers also are equipped with 115-volt taps for the lighting circuits, which are carried through automatic throwover switches to insure a supply of light regardless of which transformer is in operation.

The 26 cooling tower motors have independent control from a special panel in the turbine room basement, with a pilot light in each control circuit to indicate which of the motors are in operation. The service comes from the high-tension house-service buses through two circuits with a throwover switch, and is stepped down by transformers at the towers.

The main buses are tied in with the old railway plant and they also supply 600-volt direct-current railway service. The transfer is effected through a double-circuit rectifier transformer and two 400-kw. mercury arc rectifiers, one in each secondary transformer circuit.

As is usual in all new plants built by the holding company, the engineering and construction work has been carried out under the immediate supervision of G. T. Shoemaker, vice-president of the United Light & Power Engineering and Construction Company, with headquarters in Davenport, Iowa.

MECHANICAL AND ELECTRICAL EQUIPMENT, K STREET STATION, LINCOLN, NEB.

Building volume, cu.ft. per kw.:
- Boiler room 37.10
- Turbine room, including office 26.05
- Switch house 7.72

Boilers, 2, Walsh & Weidner cross-drum, 10,506 sq.ft.; steam 600 lb., 740 deg. F.; max. capacity 140,000 lb. per hr. .....Combustion Eng. Corp.

Furnace volume, cu.ft. 5,800

Heat release, B.t.u. per cu.ft. of furnace volume.....33,800

Water walls, cast iron, armored type, 727 sq.ft. per boiler .....Foster Wheeler Corp.

Superheaters, combination convection and radiant; max. temp. 140,000 lb. steam per hr., 740 deg. F., Foster Wheeler Corp.

Stokers, two Taylor underfeed, hyd. operated, 11 retort, 41 tuyères; grate area 344.6 sq.ft.; at max. rating 55 lb. coal per sq.ft.....American Engineering Co.

Economizers, 2, steel tubing with cast-iron extended surface; 3,780 sq.ft. per boiler.....Foster Wheeler Corp.

Air preheaters, 2, Ljungström regenerative counterflow, 18,090 sq.ft. per boiler.....The Air Preheater Corp.

Fans, forced draft, two, 56,000 c.f.m.@9.1 in. water; drive 125-hp. slip-ring motor, 510 to 1,160 r.p.m., Jeffrey Mfg. Co.

Fans, induced draft, two, 80,000 c.f.m.@9.4 in. water; drive 200-hp. slip-ring motor, 315 to 860 r.p.m., Jeffrey Mfg. Co.

Cinder traps, two .....Green Fuel Economizer Co.

Stack, steel, concrete lined, 8 ft. dia. at top, 120 ft. above roof .....Drake Williams & Mount Co.

Pumps, boiler feed, 3; two 500 g.p.m. and one 300 g.p.m. @1,680 ft. head; 1,760 r.p.m.; drives, two 350-hp. motors and one 325-hp. turbine..Allis-Chalmers Mfg. Co.

Continuous blowdown, flash tank and heat exchanger of 310 sq.ft.....Cochrane Corp.

Heater, closed 4-pass, 272 sq.ft.....Griscom-Russell Co.

Heater, open, contact deaërating thoroughfare type; 267,000 lb. per hr. from 200 to 212 deg..Cochrane Corp.

Water treating system; hot process, lime and soda ash, 267,000 lb. per hr. .....Cochrane Corp.

Pump, deepwell, 1,000 g.p.m.@125 ft. hd....Layne Western

Pump, Cameron, house service, 500 g.p.m.@116 ft. hd., Ingersoll-Rand Co.

Pump, Cameron pure water, 200 g.p.m.@81 ft. hd., Ingersoll-Rand Co.

Air compressor, 111 c.f.m., 100 lb. press, 300 r.p.m.; drive, 25-hp. motor .....Ingersoll-Rand Co.

Coal handling, 75 tons per hr.; crusher rigid-hammer type; belt conveyor, 20 in. 4-ply, 342 ft. c. to c.; scraper conveyor, 67 ft. c. to c.....Jeffrey Mfg. Co.

Bunker, parabolic steel, concrete lined, 504 tons, Industrial Brownhoist Corp.

Coal larry, traveling, 6 ton.....Jeffrey Mfg. Co.

Ash handling, hydrojet, recirculating, Allen-Sherman-Hoff Co.

Pumps, 1,200 g.p.m.....Ingersoll-Rand Co.

Trolley hoist 6,000 lb. cap.....Whiting Corp.

Clinker grinder, Blake jaw crusher, 124x12-in., Allis-Chalmers Mfg. Co.

Valves high-pressure steam:
- Flanged gate and angle.....Lunkenheimer Co.
- Flanged non-return .....Schutte & Koerting Co.

Valves, small high-pressure steam and water, Lunkenheimer Co., Edward Valve & Mfg. Co.
- Flanged gate and angle.....Crane Co.
- Reverse current and atm. relief....Atwood & Morrill Co.
- Reducing .....Fisher Governor Co.

Valves, boiler blowoff.....Yarnall-Waring Co.

Valves, water-wall blowoff.....Edward Valve & Mfg. Co.

Valves, safety, boilers and economizers, Consolidated-Ashcroft-Hancock Co.

Valves, boiler feed, flanged gate and globe, Lunkenheimer Co.

Valves, boiler water level and differential pressure regulators and pressure reducing values with master controls .....Swartwout Co.

Turbine-generators, two, 6,000 kw.@70 per cent p.f., Westinghouse Elec. & Mfg. Co.
- Turbine, 2 rows impulse blades, 22 rows reaction blades, 4 bleeder points, 3,600 r.p.m.
- Generator, 3 ph. 60-cycle, 2,400-4,150 volts; direct connected 60-kw. 125-volt exciter.

Crane, turbine room, 35 ton; 48 ft. 3 in. span..Case Crane Co.

Air coolers, generator, 2-pass, 4,490 sq.ft., 23,000 c.f.m., Griscom-Russell Co.

Condensers, surface, 2-pass, 7,425 sq.ft., Westinghouse Elec. & Mfg. Co.

Circulating pumps, three, 14-in., 7,700 g.p.m.@67 ft.hd., 870 r.p.m.; drives, 2 motors and 1 turbine, 175 hp., Westinghouse Elec. & Mfg. Co.

Hotwell pumps, 2 per condenser, 150 g.p.m.@134 ft.hd.; 1,750 r.p.m.; drive 15-hp. motor, Westinghouse Elec. & Mfg. Co.

Air pumps, two 2-stage, inter and after condenser, Westinghouse Elec. & Mfg. Co.

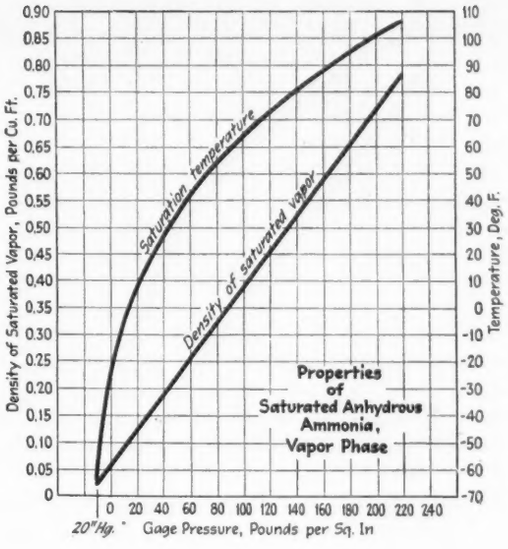
Cooling tower, comb. natural and forced draft, 9,000 g.p.m., sixteen 6-ft. propeller type fans, Foster Wheeler Corp.

Cooling tower, comb. natural and forced draft, 7,500 g.p.m. ten 8-ft. propeller type fans, Lilie-Hoffmann Cooling Towers, Inc.

Meters and instruments:
- Boiler meters and steam flow meters.....Bailey Meter Co.
- Draft gages, multi-pointer .....Bailey Meter Co.
- Thermometers, recording .....C. J. Tagliabue Mfg. Co.
- Thermometers, indicating ..... } Taylor Instrument Co's / C. J. Tagliabue Mfg. Co.
- Pressure gages .....Crosby Steam Gage & Valve Co.
- Absolute vacuum gages..Consolidated-Ashcroft-Hancock Co.

Electrical equipment:
- Switchboard, instruments, relays, 4,150-volt oil circuit breakers, 2,300-volt, induction regulators, Westinghouse Elec. & Mfg. Co.
- Oil circuit breakers, 440-volt and 4,150-volt for house service, induction regulators, house-service transformers and house-service motors..General Electric Co.
- Disconnecting switches and bus supports, Electrical Engineers Equip. Co.
- Mercury arc rectifiers.....Allis-Chalmers Mfg. Co.
- Storage battery, 124 volts, 150 amp.-hr., Philadelphia Storage Battery Co.
- Power cable, lead covered.....Anaconda Cable Corp.
- Power and control cables.Kerite Insulated Wire & Cable Co.

Fig. 1—Relation of ammonia pressure, temperature and density


Density of Saturated Vapor, Pounds per Cu. Ft.
Temperature, Deg. F.
Saturation temperature
Density of saturated vapor
Properties of Saturated Anhydrous Ammonia, Vapor Phase
20"Hg.
Gage Pressure, Pounds per Sq. In

While it is generally realized that non-condensable gas in a refrigeration system is harmful and should be eliminated, the reason why this is so is not very well known, and often the operator does not know when the system is as free of foul gas as it should be. An explanation of the few underlying physical facts is given here

Non-Condensable Gas in the Refrigerating Plant

By LEON BUEHLER, Jr.
Frick Company

REFRIGERANTS can be liquefied at definite pressures and temperatures. For example, pure ammonia will liquefy at 81 deg. F. and a pressure of 140 lb. per square inch gage, or at 50 deg. F. and 74 lb. But the refrigerant in the system is never pure. There are always some gases present that will not condense along with the refrigerant; hence the term "non-condensable gas" or "foul gas." The exact composition of foul gas is usually quite complex. It is likely to contain much air and beyond that products of various chemical reactions taking place within the system, with the amount dependent upon a wide variety of factors present in individual installations.

The operator finds that foul gas is an ever-present problem. He may have his plant comparatively free of it one day but finds it necessary to again purge a few days later. The foul gas comes from many sources. It enters from the system through leaks in piping and stuffing boxes, where part of the system operates at a vacuum. Air may be drawn into the crankcase of the compressor along with the oil. The gas may originate within the system from air that could not be entirely evacuated before charging the new system.

The refrigerant itself may break down into its component parts. Some refrigerants are less stable than others. Ammonia, carbon dioxide, sulphur dioxide and methyl chloride do not break down readily, whereas nitrous oxide decomposes easily. The lubricant may decompose under the heat of compression, or chemical reactions may take place in the system. Some common reactions are corrosion of piping, attack of lubricant or parts of the system by the refrigerant, formation of highly corrosive agents due to the presence of moisture, and reactions between dissimilar metals. There are so many substances in the system, such as the refrigerant, lubricant, materials of which the system is constructed, foul gas, moisture, core sand, rubber and pipe compound, that it is no wonder some of these substances attack one another, especially since the temperature and pressure vary over a considerable range.

These non-condensable gases collect in the high side. With proper operating conditions the outlet from the receiver is always immersed in liquid refrigerant. The non-condensable gas as well as the gaseous refrigerant is all above the body of the liquid unless a small amount of gas is in solution. Therefore gas cannot be fed to the low-pressure side of the system. The compressor, on the other hand, is constantly pumping gas from the low-pressure side to the high-pressure side, so that eventually all of the foul gas present or formed in the low side reaches the high side, from which it cannot escape.

The high side is then filled with a mixture of gaseous refrigerant and foul gas. One of the laws of physics may be stated as follows: When two or more gases occupy the same space each will be at the pressure it would have if it alone occupied the space and the total pressure will be the sum of the pressures of all the individual gases. For example, if two cylinders of equal size are filled with ammonia gas at 10 lb. per square inch absolute pressure and nitrogen gas at 20 lb. absolute pressure, respectively, and if the temperatures of the

two drums are the same the pressure in the first drum would increase to 30 lb. abs. if all of the nitrogen were transferred to it without changing the temperature. This 30-lb. pressure would be made up of a 10-lb. ammonia pressure and a 20-lb. nitrogen pressure. Each gas retains all of the physical properties of the original pressure. In the example the density, boiling point and heat content for the ammonia will correspond to these values for 10-lb. pressure and for the nitrogen these constants will be for 20-lb. pressure.

To apply this reasoning to the refrigerating plant, if ammonia is cooled in the condenser to 70 deg. the head pressure should be 113 lb. per square inch gage, as will be seen from Fig. 1. If the head pressure is any higher foul gas is present in the system. This provides an easy method to detect the presence of foul gas. A thermometer well should be inserted in the liquid outlet from the receiver, ahead of the expansion valve. With the compressor in operation the temperature of the liquid can then be compared with the high-pressure gage reading. It goes without saying, of course, that the accuracy of the thermometer and gage should frequently be checked.

It is not recommended, however, that an attempt be made to have the temperature and pressure exactly cor-

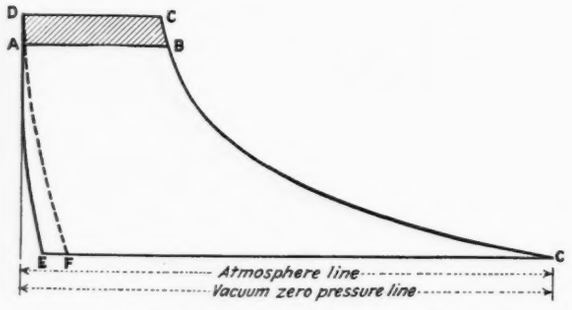


Fig. 2—Effect of foul gas on the indicator diagram

respond. It is usually impossible to bring the discharge pressure closer than within 10 lb. of that corresponding to the liquid temperature without wasting too much refrigerant by purging, and anything less than a 15-lb. differential is good. It has at times been considered that to cool the liquefied refrigerant to a pressure lower than the condensing pressure would indicate shows highly efficient operation of the condenser. It is known that the reverse is true, as subcooling of the liquid will not occur in the condenser to any appreciable extent unless foul gas is present. An exception to this is found with carbon dioxide, where the system is overcharged to secure higher capacity when operating near or above the critical point.

The fact that the pressures of the ammonia and the foul gas add up to give the head pressure is not the only reason why the head pressure goes up when foul gas is present. Due to the higher pressure when foul gas is present more heat must be removed in the condenser and the same quantity of condensing water cannot cool the refrigerant to quite as low a temperature, which results in a further increase in pressure. Furthermore noncondensable gas tends to form a film over the condenser surface, or at least at some points on the condenser surface foul gas will be in contact rather than the refrigerant. Foul gas is not as good a conductor of heat as the liquefying refrigerant. It acts as an insulator on the surface and as a result the rate of heat transfer is cut down so that the condenser loses in efficiency and the head pressure is still further increased.

The author knows of no experimental data with refrigerants to support this statement, but Prof. W. L. Badger gives some experimental results with steam. According to his data, the film coefficient between a steam and metal wall is as much as six times as great with no air present as with 4.5 per cent air. The results of air in connection with refrigerants may numerically be far different from what Professor Badger reports with steam, but the author feels certain that the presence of air will have somewhat similar effects with refrigerants.

So far the discussion has centered around the pressure and detection of foreign gases. But before the engineer attempts to correct the trouble, he must be convinced that these gases actually reduce the plant efficiency.

The first effect is increased power required by the compressor. As will be seen from Fig. 2, the increased head pressure increases the area of the indicator diagram by the shaded portion *A, B, C, D,* and as the diagram area is proportional to the compressor work this area means increased power. For example, with a suction pressure of 15 lb. gage, a head pressure of 195 lb. gage due to the pressure of foreign gases increases the power 26 per cent over that needed with a discharge pressure of 135 lb., which would exist in a gas-free system.

There are other reasons why foul gas is objectionable. The increased discharge pressure means, of course, a higher compression ratio, which reduces the volumetric efficiency of the compresser, as indicated by the suction lines *EC* and *FC* in Fig. 2, and thereby cuts down the capacity of the plant correspondingly. With the higher discharge pressure the gas temperatures run higher, resulting in thinner oil to the discharge valves and poorer lubrication. This higher temperature is also likely to result in warped or broken valves. From a safety viewpoint the higher pressures impose a greater load on the piping and vessels on the high side and failure is more likely to result.

Some of the non-condensable gas is air. Some of it may be hydrogen or hydrocarbons. At any rate, lubricant is likely to be carried to the high side in the form of gas or vapor, and in the presence of large quantities of air a highly explosive mixture results, needing only a

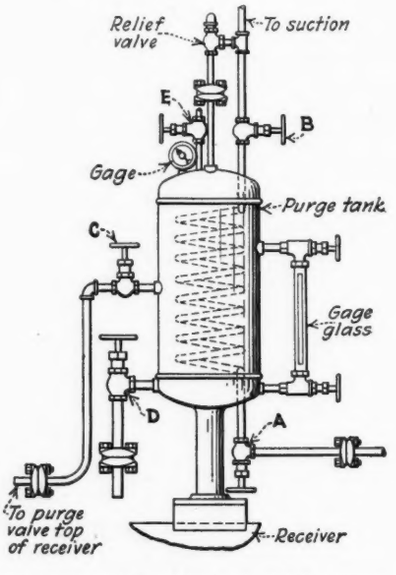


Fig. 3—Section through a Frick purger

spark to ignite it. Such explosions may be rare, but they have occurred from air and oil in air compressors and they certainly are possible in refrigerating plants if the concentration of air is allowed to get high. In plants using refrigerants that are inflammable and explosive the danger is much greater. The important fact is that air must be present in sufficient concentration to give an explosive mixture before the situation becomes dangerous. By keeping the plant well purged the operator has it in his power to prevent serious accidents.

Foul gas is removed from the system by blowing off from the high side. Some refrigerant will always be wasted along with the foul gas, and special precautions must be taken to keep this loss to a minimum. Plants not equipped with purgers must be shut down prior to purging. A full stream of water should be run over the condenser, for 30 min. after the compressor has been shut down. A purge valve from the high side gas space should then be cracked, blowing off gas slowly. It is well to lead the purged gas into an absorbent for the refrigerant, such as water for ammonia. The foul gas will bubble up through the water.

Purgers are designed to reduce the loss of refrigerant to the minimum and to permit purging while the plant is in operation. Referring to Fig. 1, it may be seen that the lower the condensing pressure and temperature of

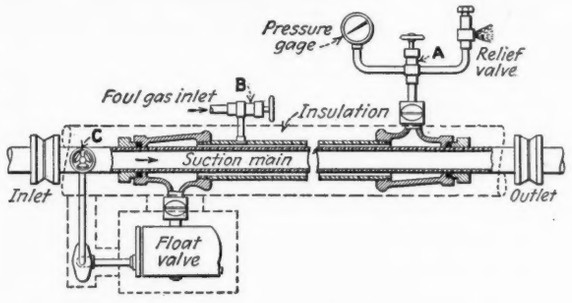


Fig. 4—A York purger cooled by suction gas

ammonia the lower is the density of the saturated vapor. For instance, with a condensing pressure of 140 lb. and 81 deg. F. the density of ammonia is about 0.52 lb. per cubic foot, while at 20 lb. pressure and a temperature of 6 deg. the density is only 0.12. The purger is simply a drum in which the gas to be purged is cooled by the refrigerating plant, condensing out as much ammonia as possible. If gas at 81 deg. is purged 0.52 lb. of ammonia will be lost with every cubic foot, while at 6 deg. only 0.12 lb. will be lost.

The gas is blown off from the purger into water just as described above. The gas going to the purger to be cooled is usually taken from the top of the liquid receiver. The ammonia flow from the condenser into the receiver carries foul gas along with it and has a tendency to prevent this gas from returning to the condenser, which makes the concentration of foul gas high at this point. If certain types of pipe condensers, such as the drip are used, where the gas from the condenser enters near the bottom of the condenser and the liquid is led off from several points below the top and where the top of the condenser is dead-ended, it is necessary to take the foul gas to the purger from the top of the condenser, as some will be trapped in the top of the condenser.

There are few points in the operation of a refrigerating plant where inefficiencies are as obvious and as easy to correct as those resulting from foul gas. Purging pays handsome dividends.

Maintenance of Pulverizer Parts

By M. C. CARVER

WHEN pulverized coal first came into use a great deal was said about the cost of drying the coal and the cost of pulverizing it. We hear little about these subjects today, because great improvements have taken place in methods and equipment, for example, the use of secondary air for drying the coal at the pulverizer. Many engineers who have adopted pulverized coal during the last few years and who until that time took little interest in the development of pulverized fuel know little about the discussions that were encountered twelve or fifteen years ago in regard to pulverizing and drying costs.

The result is that today engineers using pulverized coal do not know to what extent the cost of pulverizing adds to the cost per 1,000,000 B.t.u. or to the total cost of producing heat or power. The cost of maintenance, which includes the cost of replacing the hammers, is bunched in the plant maintenance cost. But how many enigneers know what it is costing to replace pulverizer hammers each year? How many of them have ever stopped to analyze this problem to determine the metal-and-metal treatment best suited to the problem to give longest hammer life? How many engineers have experimented with their pulverizers to determine the size of coal most beneficial not only for over-all efficiency but for maximum hammer life, or to determine how full the pulverizer should be maintained and what effect this has upon the life of the hammers?

In one plant employing two pulverizers during three years of practically continuous operation, where coal consumption averaged approximately 2,300 tons per year, the hammers had to be replaced an average of every three months, so that eight sets of hammers were required annually for the two pulverizers. At $5.10 per set this gave an annual hammer cost of $40.80. Along with an average of 2,300 tons of coal per year, the cost of hammer replacements slightly exceeded 1.77c. per ton.

Experiments were made to determine the effect of different metals or metal treatment on the life of the hammers. One test consisted of surfacing the hammers by a patented process, so producing a thin film of an intensely hard metal, but without any apparent results. Chromium plating was attempted, without any radical improvement. Finally, the hammers were heat-treated, with the result that two sets of hammers now last one year, and are still in service after three months of the second year, without any apparent erosion. The life of the hammers has been increased from three to more than fifteen months, with a probable life of twenty months. To this saving and to the cost of replacement should be added the cost of shutting down and making the repairs, work which necessitated operating the second boiler at almost 300 per cent rating. Since heat-treating the hammers, it has been the practice to keep the pulverizer filled, the idea being that perhaps a full pulverizer will tend to lessen the amount of attrition due to bombardment of the hammers by loose coal.

In the present instance the actual dollar-and-cents saving is not great, although the percentage of saving is high. In other cases, however, where more boilers are installed and larger pulverizers are in use, such savings might be very worth while.

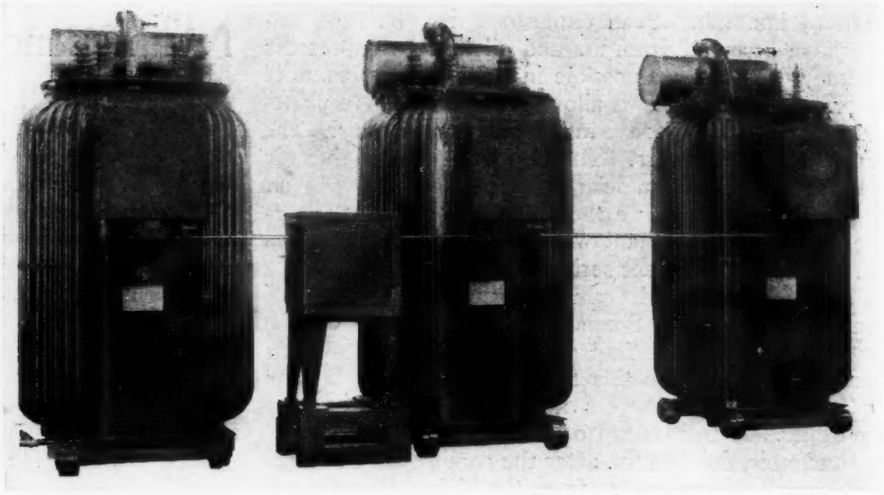


Fig. 1—Bank of three single-phase transformers equipped with load-ratio voltage control and a common motor drive

Variable-Ratio Voltage Control for Industrial-Plant Transformers

By A. G. DARLING and A. PALME
General Electric Company

WITH MOST any usual operating ratio of voltages and sizes of transformers, it is now possible, with economy, to effect a transformation-ratio change under load by the combination of equipment known as load ratio control. Whether this equipment operates automatically or under the supervision of an operator is a matter for selection according to the particular conditions.

For certain types of application, it has been found desirable to provide ready access to a multiplicity of taps in transformer windings. Manufacturing processes, constants of electrical circuits and variations in primary-voltage supply can all be predicted within limits, but are frequently changed after initial construction is completed and are sometimes beyond ready control. The changes affect, particularly, voltage, power factor or wattless current. Until a few years ago it was common practice to take whatever voltage was secured from a transformer tap and not shut down to change it as frequently as was desired, due to the time taken and the hazard to life and equipment accompanying the tap change. Today load ratio control allows changing the voltage of transformers and alternating-current lines under load.

Among the common conditions which can be modified or corrected by load ratio control are:

1. Variable secondary voltage caused by variations in the primary voltage as created by physical changes in the primary circuit; changes in loading of the primary circuits; and changes in wattless current in the primary circuit.

2. Variable secondary voltage due to changes in loading of the secondary circuits; changes in wattless current in the secondary load circuits; and changes in the distribution of wattless current between secondary- and primary-voltage sources of power.

With constant or relatively constant primary voltage, variable secondary voltage is sometimes required by the demands of process or experimentation. Some of these applications are arc and induction furnaces, resistance heating, welding, electrolysis by conversion to direct current, etc. In the same group, it also becomes necessary to have close control of the voltage.

Among the more important classes of voltage maintenance is that required to give maximum efficiency of illumination. When it is considered that 5 per cent undervoltage at the lamps causes 16 per cent less candlepower in addition to other losses, voltage maintenance becomes an important item. The importance of this is not alone from the standpoint of cost but also from safety and efficiency considerations of those depending on the illumination.

The use of load ratio control for varying the direct-current voltage by means of taps on transformers supplying either synchronous converters or rectifiers has become quite common. Simplicity and efficiency appear to favor this method in preference to others.

Many purchasers of alternating current have their own generators which operate in parallel with the purchased power supply. The use of load ratio control on the power-supply transformers provides a means for controlling the voltage and maintaining the power-factor of the purchased power within favorable limits. Voltage regulators on the local generator can be used to maintain the bus voltage at a constant value. By using a regulator somewhat similar to that used on the generator and

an out-of-phase current transformer, the wattless current taken by the purchased power supply can be controlled. This does not interfere with the division of load between the two sources, as that is a function of the speed governors of the two systems either under hand or automatic load control.

While losses in distribution have been given attention, they have usually been reduced by the addition of circuits. A combination of the correct amount of conductor, with voltage regulated for the variable load, may also be found to have economic possibilities.

Network systems of distributing power to concentrated factory loads lend themselves to continuity of service with good voltage levels over the network, provided the supply voltage is fairly constant. Simultaneous operation of tap changer from a central point of voltage detection will counterbalance variations in primary voltage without creating unequal secondary voltages.

Control of power division between paralleled transmission lines is also a practical plan, though not often required; it is accomplished by phase-angle control through the medium of the load-ratio equipment.

Of the various methods known to change the turn ratio of transformers during full load and without interrupting the main flow of power, practical experience and economy of design have led the General Electric Company to a standardization of two methods, known as parallel circuits and potentiometer connection.

With the parallel circuits method, near the middle of the transformer winding or at the neutral in grounded star-connected transformer banks where the changeable taps are to be provided, there is a break about which are brought out tap leads for the steps of operations desired, for example nine. These leads are tied to two ratio adjusters each with nine contacts. The two common terminals of these ratio adjusters are connected through two current-interrupting devices to the two ends of a small reactor from the middle of which the broken transformer winding is continued, Fig. 2. With both contactors close and the selector switches on the same tap, the load current will divide equally through the two branches, subjecting each selector and interrupter to one-half of the operating current.

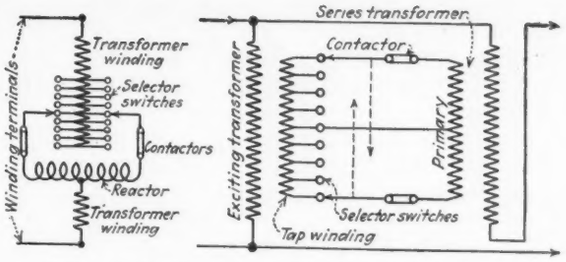


Fig. 2 (Left) — Diagram of parallel-circuit method of load ratio control in a transformer winding

Fig. 3 (Right)—Diagram of potentiometer-connection method of load-ratio control in a power line

Where either the primary voltage or the secondary current of a transformer is high, it may be found advantageous to place the tap-changing equipment in a local circuit separate from the transformer and is accomplished by the potentiometer-connection method. The voltage and current of the local circuit can be chosen to best suit the switch gear. This will require two transformer cores, which are placed, as a rule, in a common tank. Fig. 3 shows a typical arrangement of connections. Two selector switches travel up and down and past each other along the tap winding, impressing more or less voltage upon the primary of the series transformer. This gives a simple way of obtaining several buck and boost positions with the load ratio-control equipment in its own isolated circuit. To prevent current interruptions on the selector switches, two separate current-breaking devices are used in the two circuits. A mid-point connection between the tapped winding and the primary winding on

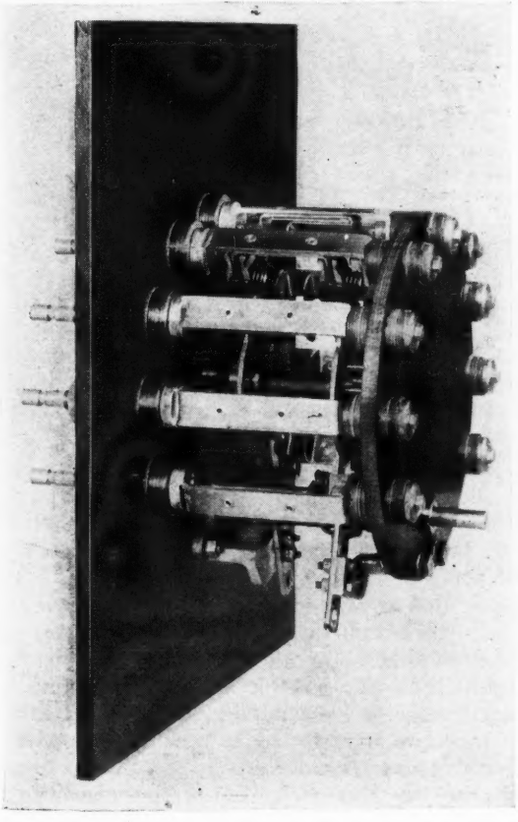


Fig. 4 (Left)—Twin ratio adjuster for transformer load ratio control. The construction comprises essentially two dial switches, each operated by a Geneva stop gear and a driving pawl

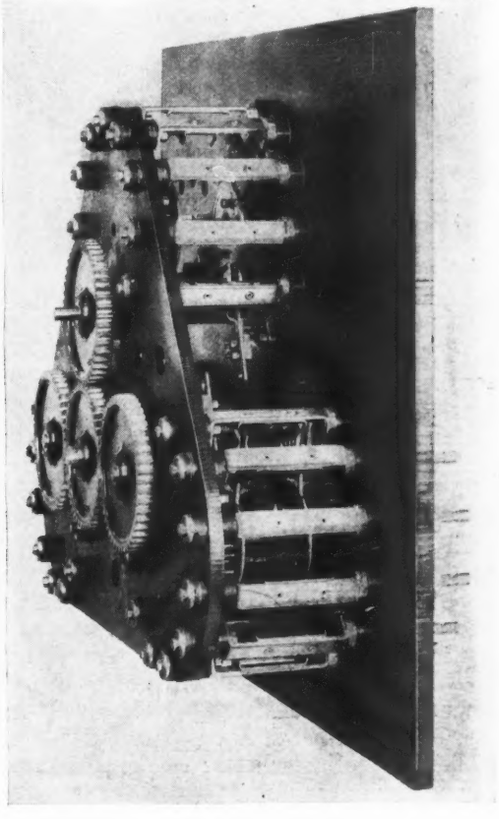


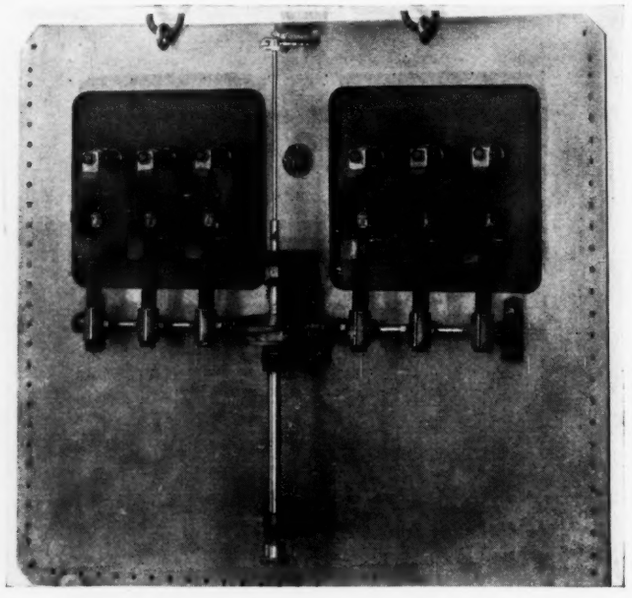
Fig. 5 (Right)—Three-phase twin ratio adjuster for transformer load ratio control. This unit consists of three twin ratio adjusters mounted in a clover-leaf arrangement on a common base plate

the series transformer assures continuity of current during the switching process.

For general power-transformer applications several types of load ratio-control apparatus have been developed. These follow the same electrical principle, their differences lying in their individual ratings and their mechanical designs. Two of these equipments are especially adapted by their ratings for industrial applications. One of these is for currents up to 400 amp. and the other is for currents up to 100 amp. in circuits up to 15,000 volts.

For equipment limited to 400 amp. and for single- or three-phase circuits up to 15,000 volts, to comply with Fig. 2 two selector switches or ratio adjusters are required. The individual points of these are connected to one set of transformer taps. To insure the proper mechanical sequence of operation, provision has to be made to move these two sets of switches one at a time. It has been found possible to combine the two ratio adjusters into one piece of apparatus called a twin ratio adjuster, Fig. 4. The construction comprises essentially two dial-type switches, each operated by a Geneva stop gear and a driving pawl. When turning the main driving shaft one complete revolution, each dial switch will be moved a definite angular distance from one tap contact to the next.

The dial switches have stationary knife contacts and



self-aligning clip contacts. Pressure on the clips is maintained by helical compression springs. The stationary contacts are copper bars to which are riveted and welded copper blades. Nine of these copper bars are held in a cage-like fashion between two heavy insulating end-plates. The moving clip contacts are attached to two Geneva gears, moulded from insulating compound each with nine scallops, corresponding to the nine fixed contact bars.

Electro-dynamic stresses in case of a short-circuit are eliminated, since the contact clip grips the stationary blade from both sides. Tests with over 25 times normal current, more than 10,000 amperes, showed neither welding nor sputtering. One such unit is required for a single-phase transformer; three of them for three-phase, mounted in a clover-leaf arrangement on a common baseplate, Fig. 5. It is customary to use the rear plate of the twin adjuster as an oil-tight window, fitting over an opening in the upper part of the transformer tank so that the adjuster is mounted in its own oil tank outside the main tank.

The current-carrying and current-interrupting duty of these equipments, being limited to 400 amperes, makes possible the use of a relatively simple design of contactor, Fig. 6. The contactors are mounted on an insulation panel, and operate through insulating arms. A circular metal scroll cam, located between the two contactors, causes them to open and close in proper and definite time sequence with the twin ratio adjuster, which is driven by the same shaft. The contactors, with their cam mechanism, are located in a small square steel tank, which contains also the twin ratio adjuster.

Depending upon local circumstances, various methods of remote motor control are applicable to these small load ratio-control equipments. A bank of three single-phase transformers can be operated by one motor drive with interconnecting shafts between the three units. Universals and slip-joints in the interconnecting shafting make misalignments in the set-up of the individual transformer units, of no consequence, Fig. 1. It is also possible to provide each single-phase unit with its own individual motor drive, all of them connected to a common control switch, so that they all pick up together and complete their cycle of operation as governed by a controller on each unit.

Fig. 6 (Left)—Three-phase contactor panel for a transformer load ratio control. The contactors are mounted on an insulation panel and operated through insulating arms

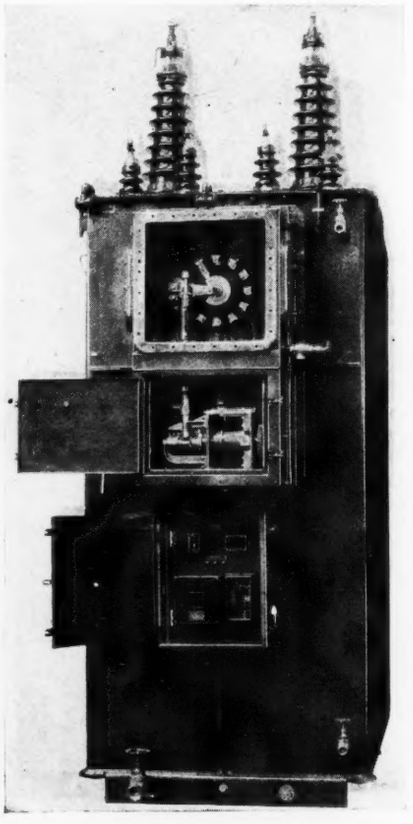


Fig. 7 (Right)—Single-phase 500-kva. transformer equipped with automatic load ratio control, showing the oil-immersed ratio adjuster, operating mechanism and control panel

For loads limited to 100 amp. and for circuits up to 15,000 volts the tap-changing equipment may be single or three phase. To insure a wide zone of application, the same range of 10 per cent buck and 10 per cent boost or a total of 20 per cent in nine equal steps is used. For industrial application remote-manual control will probably outnumber full-automatic operation, but provision has been made for either. In addition, emergency hand-crank operation is always possible. In this equipment the ratio adjusters themselves act as arcing devices, taking on their own contacts the slight amount of arcing occasioned by this low rating.

Instead of providing the mechanical motive power for

resetting the contacts from tap to tap directly by a remotely controlled motor, which would require a fairly substantial size to give the desired contact speed, a very small motor is used to wind a strong helical spring. It is the energy stored in this spring that operates the twin ratio adjusters and resets them in about 0.025 sec. per finger or about 0.05 sec. for the two of them.

A spring drive of this type has a number of features which make it particularly applicable to automatic control of transformer load ratio control. The 0.001 hp. motor required for winding the spring has a starting current so small that it can be controlled directly from the contacts of a standard contact-making voltmeter. Starting and reversing of the motor is done by making contact on an upper or a lower contact of the contact-making voltmeter. The time required for the winding of the spring introduces automatically the desirable time-delay feature, about 20 sec., which otherwise would have to be obtained from a separate time-delay unit. It is characteristic of the spring drive, that the switching apparatus cannot start a change of taps until the motor has completely wound the spring. If a rise or fall of voltage lasts only a few seconds and rectifies itself again, the motor will have wound the spring only partially, and the retaining latches will not give way. On the other hand, once the spring has been fully wound, the switches will be reset definitely, with no possibility of stopping in a halfway position.

A single-phase 500-kva. transformer, equipped with a load-ratio-control apparatus, arranged for fully-automatic control is shown in Fig. 7. All moving parts are external to the transformer, and the figure shows how accessible they are for inspection. A three-phase equipment has two more adjusters above the one shown, at top of the transformer, all three in a vertical line and driven from the mechanism below.

For remote hand operation the lower cabinet in Fig. 7 is omitted, and on the operating switchboard is mounted a control switch. A set of small indicating lamps, one for each position, serves to notify the operator that the switching apparatus has arrived at the selected position. It is also possible to furnish load-ratio-control equipments of this new type with a combination of automatic and manual control, so that, depending upon circumstances, either method can be cut into service.

▼

Proper Size Float Important

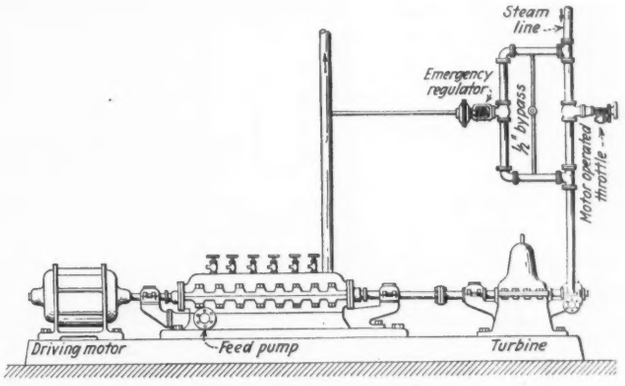
IT IS important when installing a float switch that the proper size float be used. It occasionally happens that the one installing the control substitutes any float that is available. As long as the piece of equipment that the float switch controls works satisfactorily, no trouble is had. But if something fails to work properly, there is a good chance of the switch being damaged if too large a float has been used.

For example, a float switch may be used to operate a pump connected at the base of a tank and the float within the tank closes and opens the switch each time the water level rises and falls. Assuming that through some motor trouble the pump fails to operate, the float will reach its maximum position to start the pump, and then will be submerged. This will produce considerable pressure on the float, sufficient in some cases to break the float or switch arm or bend the interconnecting link if a larger float than necessary has been used.

Saving Possible With Dual Pump Drive

By H. M. SPRING

IN INDUSTRIAL plants with the boiler supplying steam to a turbine-generator the boiler must, of course, be of a size sufficient to carry the maximum load with good economy. In many plants, however, a certain definite average load is carried one part of the day and a different average load is carried the rest of the time. For example, a plant of this type carries a power load for a group of buildings of 650 kva. through the day and after dark an additional lighting load of 350 kw. is imposed. The boiler must therefore be large enough to carry better



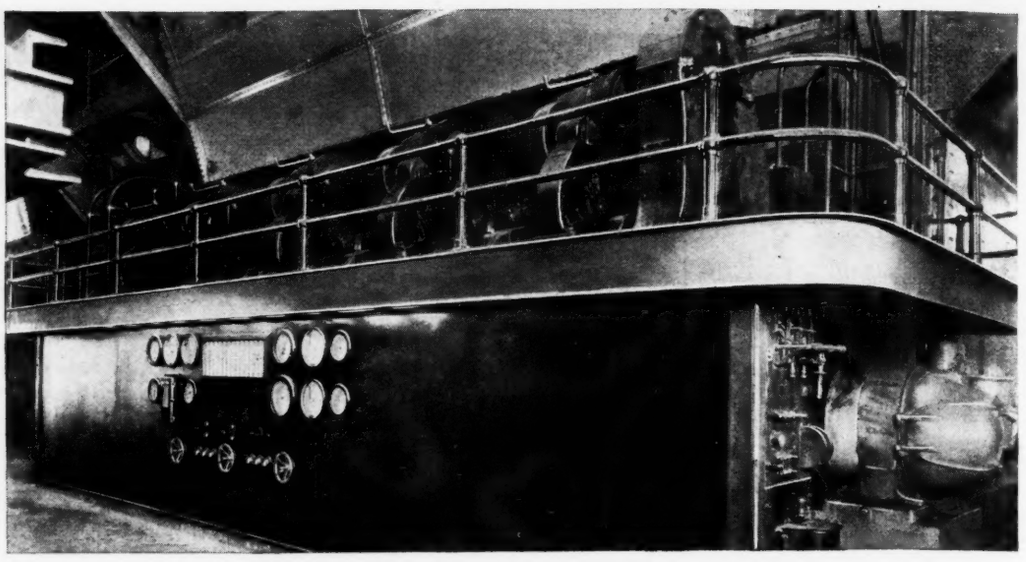
Pump drive suggested

than 1,000 kw. on the turbine without excessive furnace or stoker maintenance or drop in efficiency. On the basis of a boiler purchased to carry this load, the loss at the lower load will come back onto the fixed charges. In addition there is a loss due to the drop in efficiency at the lower furnace temperature. This results from the excess steaming capacity available but not being used.

One way to reduce this loss in a plant with electrically driven auxiliaries will be to use a dual-drive feed pump, as shown. As the load on the plant rises past 88 per cent of full, the current transformers operate the relays. One of these causes the oil switches in the feed pump driving motor lines to close, starting the motor drive. This is on the assumption that the turbine drive is already running. At the same time the relay also operates an auxiliary relay for the magnetic contacting switch on the motor-operated throttle valve to the turbine, closing this. A ½-in. bypass supplies cooling steam to the turbine. With this system a higher boiler output is available for full load. The gain is due to the fact that the larger turbine is of considerably higher efficiency than the small non-condensing turbine driving the pump.

When the load on the station again drops below the setting on the under-current relays the feed-pump motor will run idle, with the load carried on the turbine.

Should there be any electrical failure in the circuit of the driving motor while the throttle valve is shut, the emergency regulator will open when the feed-water discharge pressure drops. This also opens if the throttle does not open quickly enough to keep the pressure up when the changeover is made. By this connection the feed-water pressure is kept nearly constant at the pump discharge when changing the drive.



Modern large underfeed stoker installation complete with motor drive and instrument control board

Underfeed Stokers for Heating, Industrial

UNDERFEED stokers can logically be divided into three definite classes: small-sized single-retort units for heating and small industrial boilers of 150 to 1,500 sq.ft. of heating surface; medium-sized single-retort units for boilers of 1,500 to 5,000 sq.ft.; and the large-capacity multi-retort units for boilers of 5,000 sq.ft. up.

In the smaller units both screw and ram type of feed are used, with the screw feed predominating. These stokers are designed, essentially, for use under low-set return-tubular and firebox type heating boilers and can usually be installed in the place of a hand-fired grate with a minimum of alteration to the furnace or setting. These small units operate invariably at low combustion rates and intermittently rather than continuously. Some, however, are designed for continuous operation, and embody the principal feature of the larger units, being equipped with agitating tuyères and dump plates.

The single-retort stoker in the medium-sized class has found wide application to industrial power boilers in sizes from 1,000 to 6,000 sq.ft. This stoker can handle a wide range of non-coking and coking bituminous coals and is adaptable to a wide range of conditions. Being of the side-dump type, it requires no basement, which reduces building costs and makes it applicable to existing boiler installations. Continuous combustion rates from 25 to 40 lb. of coal per sq.ft. per hour are possible, contingent upon the furnace width; under certain conditions, combustion rates as high as 50 to 55 lb. per square foot per hour can be reached to meet peak-load conditions. Single-retort units are built in widths up to approximately 12 ft. and in lengths up to 9 ft., giving a maximum grate area of around 110 sq.ft. In this class of unit the coal is distributed through the retort by pusher blocks operated from the coal-feeding ram and is distributed over the grate surface by lateral grate motion, the amount of which may be adjusted in accordance with the burning characteristics of the coal.

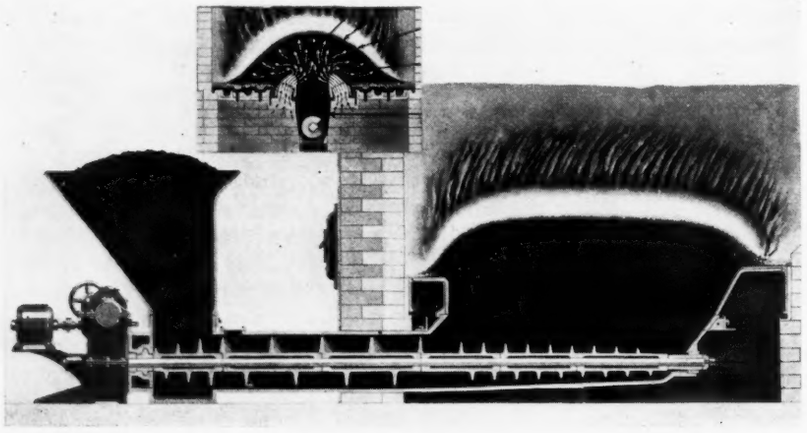


Fig. 1—Modern Coal Burner screw-type stoker with independent forced-draft fan

Stokers of this type employing a horizontal grate and side dump are also available in double- and triple-retort design, but these units are

This, the second article of a series, describes underfeed stokers of the single-, double- and multi-retort types. These embody screw and ram feed units in sizes for heating and power boilers of 150 sq.ft. of heating surface up. A third article will treat chain- and traveling-grate types. The first article appeared in the Dec. 15 number

and Power Boilers

generally applied only where depth of existing furnace or other limitation does not permit the use of a multi-retort with rear ash discharge.

Although the multi-retort probably cannot compete with the single-retort, side-dump units on boilers below 4,000 sq.ft., because of the short retort that would be necessary, where high ratings are to be maintained over long periods and widely fluctuating loads or sudden peaks must be met it has certain inherent advantages. By virtue of its design it has a higher fuel burning capacity per square foot of grate area than is obtained with a side dump and it is not limited as to size by width and depth of furnace. A greater degree of agitation is generally provided, giving more flexible control over fuel bed thickness. On the larger units a clinker grinder can be employed which allows continuous discharge of the ash, thereby permitting high combustion rates to be maintained over long periods.

A typical illustration of the screw-feed type of unit is shown in Fig. 1. The coal is fed to the retort and distributed by a screw of varying diameter and pitch. The retort sides are made high and practically straight, with the tuyère assembly designed to give a rounded fuel bed of practically uniform thickness with relation to the upper surface of the tuyère. With this unit an independently driven forced-draft fan is placed at the front or side, as best suits installation requirements.

Other screw-feed units embody somewhat different characteristics. Some have the driving motor, forced-draft fan and gear box incorporated in one unit and a grate surface comprising laterally agitating grate bars and dropping ash plates all under forced-draft air control. Various combinations of the features of these two units are embodied in the other screw-feed stokers listed in the table.

In the hydraulically operated unit, Fig. 2, oil pressure is furnished to the operating cylinder by a combined motor-driven oil pump and forced-draft fan. This unit can be placed in any suitable location adjacent to the stoker and the interconnection between it and the operating cylinder made with pipe or flexible tubing. Regulation of the ram speed over an unusually wide range is effected by a control valve incorporated in the oil-pressure line at the pump. With this control the length of stroke and oil pressure remain constant for all rates of feeding, the speed of the ram only being altered.

To provide the necessary flexibility in operation with any size of underfeed it is essential that the speed of the stoker ram or the length of the stroke be readily adjustable over considerable range. Where the stoker is driven by a steam or hydraulic cylinder, or a steam turbine, adjustment of the speed is provided by means of a timing valve or governor, controlled either manually or automatically by the boiler pressure.

For some installations, however, an electric motor drive is preferable; but it is not as flexible in operation as the steam or hydraulic drive, and some additional

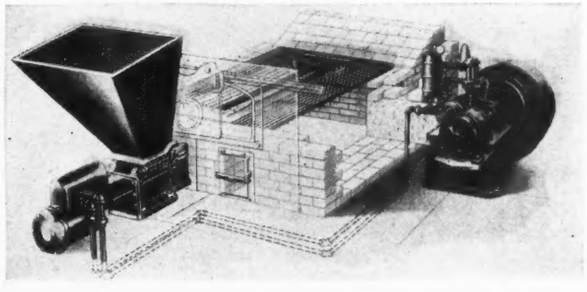


Fig. 2—Auburn hydraulically operated industrial stoker with pressure pump and fan in a single unit

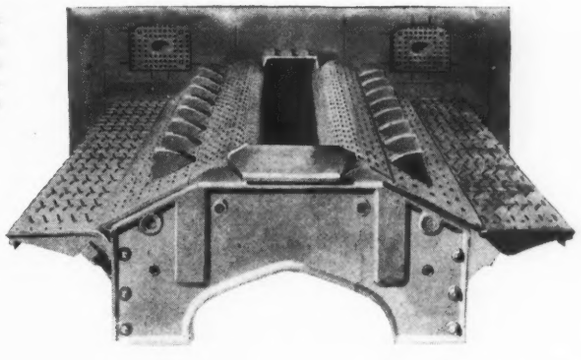


Fig. 3 — Flynn & Emrich single-retort stoker with lateral grate motion and zoned air box

means of adjusting the speed must be provided. This is effected in a number of ways: by the use of an adjustable speed motor with flexible drive to the stoker gear box; variable-speed transmission between motor and stoker, multiple-speed gear box; and by changing the amount of lost motion on the connecting rod between the crank and the ram, which permits the ram to short-stroke and thereby feed less coal to the retort.

An electric drive designed to embody the quick-thrusting action of the steam ram and at the same time provide a coal feed between 60 and 6,000 lb. of coal an hour is shown applied to a single-retort unit in Fig.

4. The number of strokes, per minute or per hour is regulated by a specially designed timing mechanism inclosed within the gear case.

A somewhat different type of electric drive, employing a constant-speed motor, has been developed recently for the steam-operated stoker illustrated in Fig. 6. The drive employs a double-worm reduction gear and the variation of coal feed is accomplished by changing the number of strokes per minute while keeping the speed and length of stroke constant. For stokers requiring up to 7,500 cu.ft. of air per minute a forced-draft fan is incorporated in the drive.

Because the multi-retort underfeed stoker is designed, essentially, to burn coking bituminous coals, a fundamental requirement is that adequate means be provided for agitating the fuel bed sufficiently to keep it porous and prevent large lumps of coke forming and cutting off the air flow, and to move the ash and clinker to the dump plate or clinker grinder pit progressively. Especially is this important in the larger-capacity units that must operate continuously over long periods.

In the units shown in Figs. 7 to 13 this is done in a number of different ways. The method employed in the horizontal unit, Fig. 7, is similar to that used in the side-dump types: a slicing bar with pusher blocks attached force the coal upward and rearward, the stroke of the bar being adjustable over considerable range.

Secondary rams having an upward as well as a longitudinal movement agitate the fuel bed and distribute the coal in the unit, Fig. 8. These rams receive their motion from an oscillating link near the front which is operated from a connection to the main ram. The stroke of the rams is variable, and each is separately adjustable. The amount of motion given to the rams as a unit may be changed by a handwheel. Grate bars at the lower end of the retort also have a variable travel and move in sections. In this stoker the feeding ram consists of a rectangular section attached to a semi-circular section. This design permits changing the height of the rectangular section in relation to the stoker length, thereby increasing the coal-feeding capacity of the ram without changing the crank speed.

In the method employed of distributing the coal over the grate surface, the stoker in Fig. 9 differs materially from other types of multi-retort units. Reciprocating retort sides with the tuyères mounted on their upper surface give control over the fuel bed and serve to move the fuel toward the rear of the furnace, no pushers being used in the bottom of the retort. The travel of each pair of retort sides is readily adjustable from zero to maximum. The same reciprocating action is imparted to the overfeed grate section and rocker dump plate. In the new design of this unit, recently completed, the reciprocating side bars are carried on self-aligning shoes at the front and rear. This construction removes all weight from the sidebar rods, which serve to transmit motion only. In the longer units employing two-piece sidebars a central self-aligning shoe is added. Like the retort bottoms, the shoes supports are carried by longitudinal members of the substructure, without central support. In the new design of gear box the drive shaft is placed above the oil level, obviating packing troubles.

The interposition of a link-grate section between the overfeed section and the ash-discharge device and the use of an inclined in place of a horizontal coal ram characterize the unit in Fig. 10. The link-grate section consists of narrow grate bars or links assembled in units corresponding in width to a single retort. The upper row, crosswise of the stoker, is pivotally connected to the lower ends of the underfeed section. The rows, five in

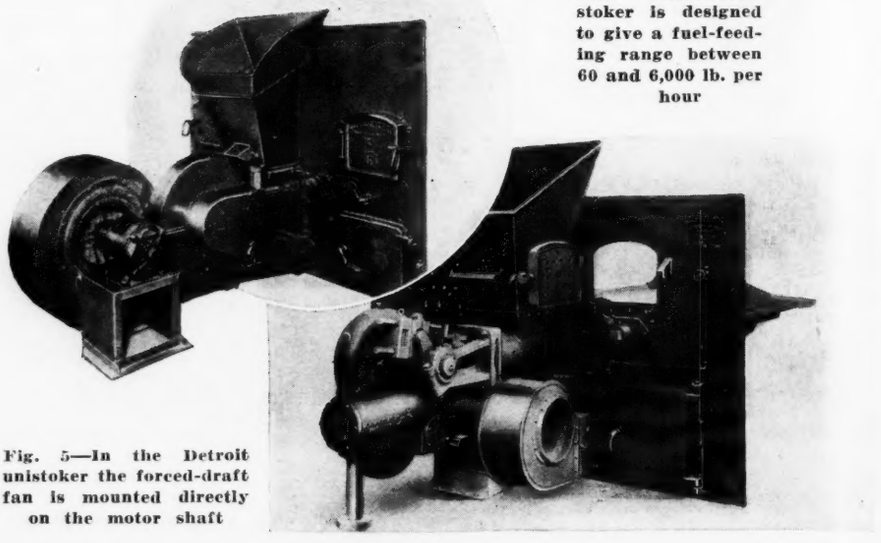


Fig. 4 — The "Riflex" drive for the Jones single-retort stoker is designed to give a fuel-feeding range between 60 and 6,000 lb. per hour

Fig. 5—In the Detroit unistoker the forced-draft fan is mounted directly on the motor shaft

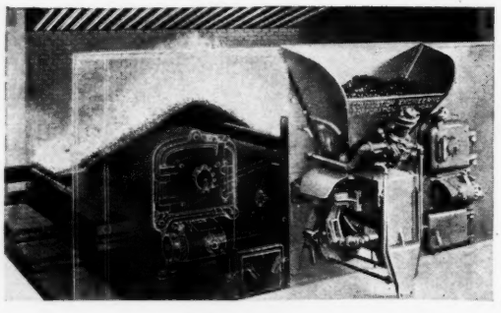


Fig. 6—C-E Type E steam-driven single-retort stoker. An electric drive with integral fan can also be applied to this unit

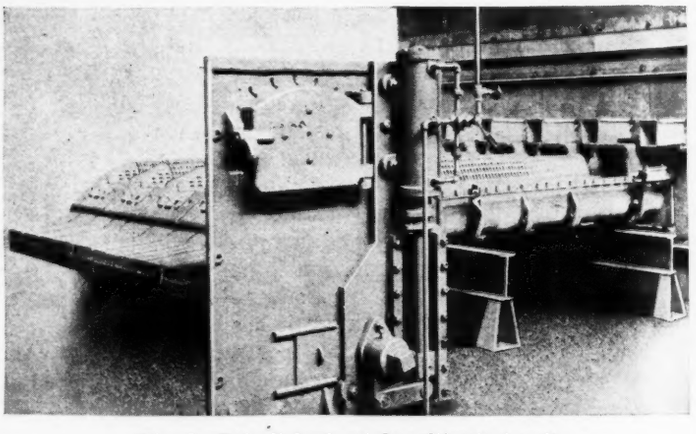


Fig. 7—Detroit horizontal multi-retort unit with steam-operated rear dump plates

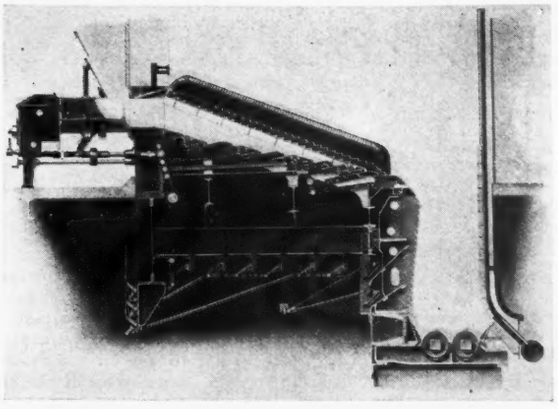


Fig. 8—C-E multiple-retort stoker, superstation type, with zoned air control and clinker grinder

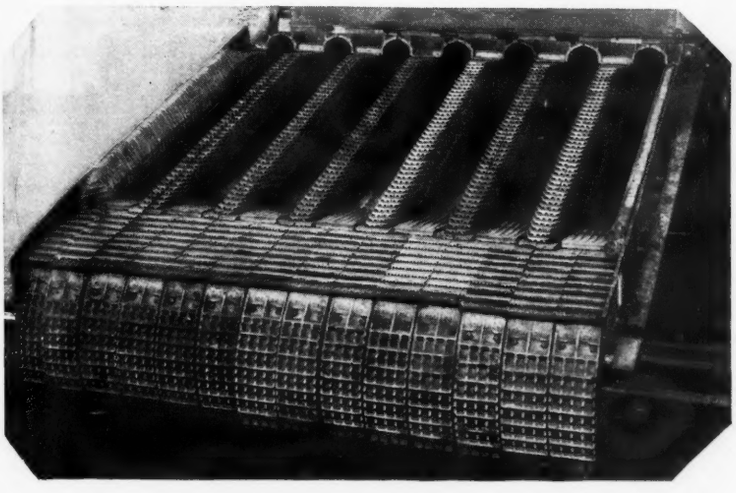


Fig. 9—Riley Model R multi-retort stoker with improved sidebar construction and substructure requiring no central support

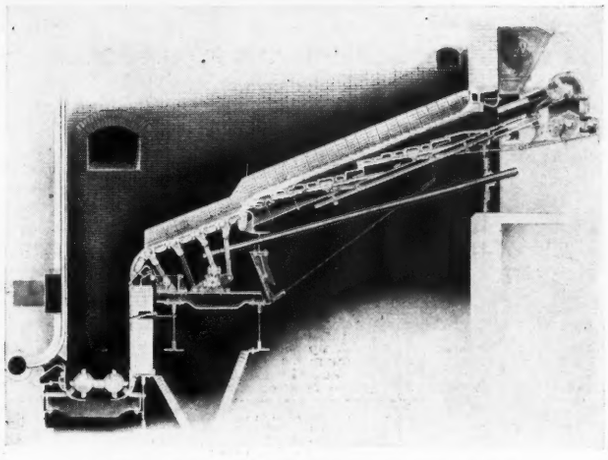


Fig. 10 — Westinghouse multi-retort stoker with undulating link grate between underfeed section and ash discharge

feed of the fuel can be graduated throughout the retort by individual adjustment. The amount of travel given to the extension grate controls the agitation of the fuel bed at the rear and the movement of the ash toward the dump. Provision is made in the design of the power-operated dump for overtravel above the normal position to remove clinker or other adhesion from the bridge wall.

Designed to eliminate angular thrust on the coal-feeding rams and distributing pusher, the straight-line drive shown in Fig. 12 is used on high-capacity stokers. The coal-feeding ram is driven off the crankshaft by a connecting rod which actuates a threepoint bell crank mounted on a jack shaft. The coal feeding ram is connected to an arm of the crank by a short connecting rod, thus eliminating the vertical component of the force produced in the standard drive. The other arm of the bell crank operates the distributing pushers by means of rods brought out at the front of the stoker, which is adjusted by use of horseshoe-shaped collars.

To meet the demand for larger fuel-burning capacities with increasing size of boiler, the unit shown in Fig. 11 was designed to underfeed coal practically the full length of the retort. In this unit the rods for operating each pusher and each section of the extension grate are brought out horizontally to the front of the stoker, where the stroke of each may be adjusted individually. The rods are operated by a common-link mechanism connected with the coal feeding ram.

Equally important to the ability of an underfeed stoker to distribute the coal and agitate the fuel bed properly is that of tuyère design and air distribution to the bed. Recent tuyère designs show improved streamline passages and extended cooling surface that not only gives better air distribution but affords maximum liberation of absorbed heat to the air used for combustion.

all, are pivotally connected to each other, forming a chain-like surface to which a waving or undulating motion is given by an adjustable connection to the main stoker drive. Adjustment in six increments from zero to maximum are provided, and as the movements are controlled separately from that of the feeding rams it permits control of the ash discharge to the clinker grinder pit independently of the distribution of fuel in the retorts.

The three units shown in Figs. 11 to 13 are designed to cover a wide range of capacities and operating conditions. In the standard type, Fig. 13, auxiliary pushers form the bottom of the retort. Not only is the stroke of these pushers as well as the stroke of overfeed extension grates adjustable over considerable range, but the

In the larger units it is general practice to provide three or more separate air compartments or zones below the grate, so that by means of dampers the amount of air may be suited to the thickness of the fuel bed directly over any particular zone. A design of unit is now available in which the fuel bed is not only divided into zones but each zone is again divided into sections or unit areas each provided with a manually operated control damper and a venturi metering throat. With this arrangement the operator is able to maintain a predetermined distribution of air regardless of variation in fuel bed resistance.

Inasmuch as the success of any present-day installation is dependent primarily on proper operation in

service, a few simple rules can be added which if followed should do much to assure satisfactory and more efficient operation in the average plant. They are: operate the stoker at all times as near ratings of maximum efficiency as possible; keep to a minimum the number of boilers on bank; keep fires clean and side and bridge wall free of clinkers; anticipate steam demands and build up fires to meet peaks[1] reduce when over; have grate well covered when banked; keep stoker well lubricated, clean and in good state of repair; and lastly, endeavor to obtain results under everyday working conditions that are as close as practicable to those theoretically possible.

[1]In some plants a comparatively thin fuel bed is used and the load is brought up on all boilers.

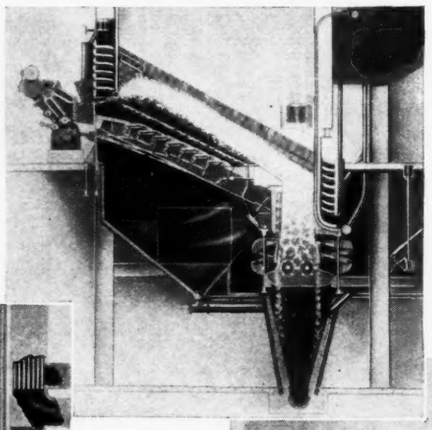


Fig. 12 (Left) — The straight-line drive furnished with Type M and P Taylor stokers is designed to eliminate the thrust on the ram due to angularity of the connecting rod

Fig. 13 (Below)—Type H Taylor stoker is built in 13 to 25 tuyère lengths and is equipped with steam-operated dump or clinker grinder

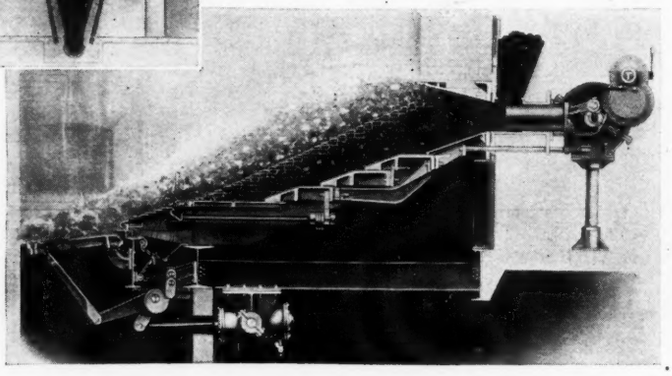
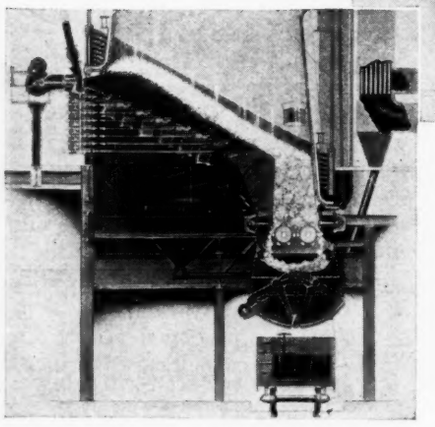


Fig. 11 (Below)—In the high-capacity Type U Taylor stoker each coal pusher and section of extension grate is driven by rods brought out to the front of the stoker



UNDERFEED STOKERS FOR HEATING, INDUSTRIAL AND POWER BOILERS

Type	B.H.S. Sq.Ft.	Drive	Feed	Grate	F.D. Fan	Notes	Manufacturer
Taylor H	2,000– 7,500	Steam	Ram	Multiple	Separate	St. oper. ash dump 13-25 tuyéres, long	American Engineering Co.
Taylor M	5,000–12,000	Electric		Retort		Straight-line drive 29-41 tuyéres, long	
Taylor P	7,500–18,000	Hydraulic				Steel plate constr. 41-53 tuyéres, long	
Taylor U	18,000–up					High capacity 48 tuyéres up	
Junior-Senior	150– 3,000	Hydraulic	Ram	S. retort	Int. sep.	Hyd. pump and fan single unit	Auburn Stoker Corp.
	100– 2,000	Electric	Screw	S. retort	Integral	Dead plate	Black Servant Manufacturing Co.
A1-R-LSR	700– 5,000	Elec.-steam	Screw-ram	S. retort	Int. sep.	Side dump	Brownell Co.
Columbus	80– 1,500	Electric	Screw	S. retort	Integral	Dead plate	Columbus Stoker Equipment Co.
Combustioneer	100– 2,500	Electric	Screw	S. retort	Integral	Dead plate	Combustioneer Inc.
C-E unistoker	100– 2,000	Electric	Screw	S. retort	Integral	Side dump	Combustion Engineering Corp.
K	500– 2,000	Elec.-steam	Ram	S. retort	Separate	Side dump	
E	1,500– 6,000	Elec.-steam	Ram	S. retort	Separate	Side dump	
Standard	3,000– 7,000	Electric	Ram	M. retort	Separate	Furnished with ash dump or power-driven clinker grinder	
Super-station	6,000–up	Electric	Ram	M. retort	Separate		
Junior	300– 1,500	Electric	Ram	S. retort	Integral		Detroit Stoker Co.
Unistoker	1,000– 3,000	Elec.-steam	Ram	S. retort	Integral	Side dump	
Detroit	1,000– 6,000		Ram	S. & D. ret	Separate	Side dump	
Detroit	3,000–up		Ram	M. retort	Separate	Rear dump—steam operated	
S	Up to 5,000	Electric	Ram	S. retort	Integral	Side dump	Fire King Stoker Co.
F. & E.	1,000– 6,000	Elec.-hyd.	Ram	S. retort	Separate	Side dump—zoned air control	Flynn & Emrich Co.
H. H.	Up to 3,000	Electric	Screw	S. retort	Separate	Dead plates	Holcomb & Hoke Mfg. Co.
Industrial	Up to 2,500	Electric	Screw	S. retort	Integral	Dead plates	Iron Fireman Mfg. Co.
Leffel	100– 2,000	Electric	Ram	S. retort	Integral	For Scotch marine boilers	Leffel & Co. (James)
Lion	100– 2,500	Electric	Screw	S. retort	Integral	Dead plates	Lion Stoker Co.
U	Up to 2,250	Electric	Screw	S. retort	Integral	Rocking and dumping grates	Marion Machine, Foundry & Supply Co.
Junior	350– 1,500	Electric	Ram	S. retort	Integral	Adjustable ram stroke	McClave-Brooks Co.
SR	1,250– 3,000	Elec.-steam	Ram	S. retort	Separate	Air zoning dampers	
D. R.	3,000– up	Elec.-steam	Ram	D. retort	Separate	Heavy-duty	
Modern	150–35,000	Electric	Screw	S. retort	Separate	Dead plates	Modern Coal Burner Co.
Kol-Master	150– 3,500	Electric	Screw	S. retort	Integral	Dead plate	Paragon Kol-Master Corp.
Perfection	750– 6,000	Elec.-steam	Ram	S.&D. retort	Int.-sep.	Side dump	Perfection Grate & Stoker Co.
Jones	500– up	Elec.-steam	Ram	S-D. M.	Int.-sep.	Side and rear dump	Riley Stoker Corp.
Riley Standard	3,000–up	Elec.-steam	Ram	Mul. retort	Separate	Rear dump—clinker grinder	
Riley Super	8,000–up						
Westinghouse	1,500– 5,000	Elec.-steam	Ram	S. retort	Separate	Side dump	Westinghouse Elec. & Mfg. Co.
	3,000– up	Electric	Ram	Mul. retort	Separate	Rear dump, link-grate and clinker grinder	
Biggs	500– 5,000	Elec.-steam	Ram	S retort	Int. sep.	Side dump	Wheland Co.
Jersey	500– 3,500	Elec.-steam	Ram	S. retort	Separate	Side dump	Woodcock, W. J.

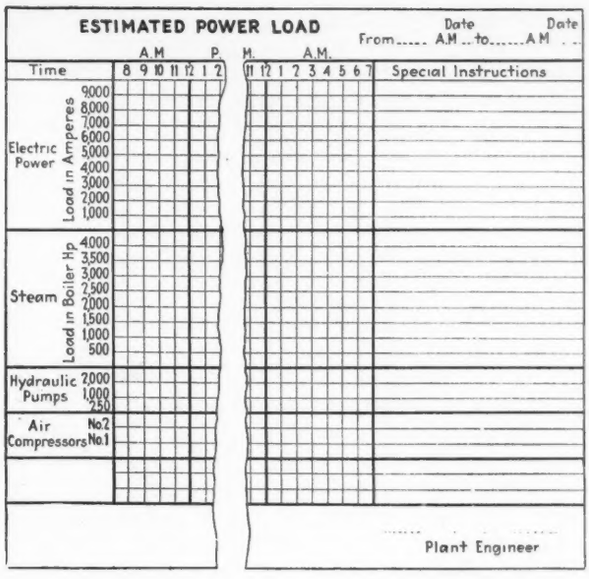

ESTIMATED POWER LOAD
From..... Date A.M ..to..... Date A.M
A.M. P.M. A.M.
Time
8 9 10 11 12 1 2 11 12 1 2 3 4 5 6 7
Special Instructions
Electric Power
Load in Amperes
9000 8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000
Steam
Load in Boiler Hp.
4000 3,500 3,000 2,500 2,000 1,500 1,000 500
Hydraulic Pumps
2,000 1,000 250
Air Compressors
No.2 No.1
Plant Engineer

Fig. 1 — Form used to show estimated hourly demand for power, steam, pumped water and compressed air

By J. C. EVANS
Chief Engineer
Republic Rubber Company

Systemized Power Management Saves Dollars in Industrial Plant

THE SYSTEM of industrial power plant control outlined in this article has been designed and is used in the plant of the Republic Rubber Company at Youngstown, Ohio, which is engaged in the manufacture of a complete line of mechanical rubber goods, besides tires and inner tubes.

The system is particularly applicable to the chief engineer, plant engineer, mechanical engineer, superintendent or the executive, whatever his title may be, who shoulders the responsibility for buildings, machinery, equipment design and operation in a large manufacturing plant, and by whom the actual generation of steam or electric power is usually considered as a minor part of his job, and is often neglected or entrusted to someone in the power house who is paid to keep the engine turning over and the steam pressure up. This situation is found in many plants and is not exaggerated, although its authenticity will be questioned by many, among whom are plant engineers who really believe that they are managing their power houses efficiently and economically.

Aside from a visit to the boiler and engine rooms daily, or most likely weekly, many plant engineers contribute very little to the actual operation of the power house, except their moral support, or more often criticism which is based on appearances only or lack of information.

Our boiler plant has six 5,000-sq.ft. boilers and one 6,500-sq.ft. boiler, fired by three underfeed stokers and four overfeed stokers. Steam is generated at 160 lb. pressure. One boiler is equipped with a 100 deg. superheater. All other boilers generate saturated steam.

Our electric power is direct current at 250 volts supplied by three 300-kw. generators driven by two compound engines and one corliss engine; one 750-kw. generator driven by low-pressure turbine; and one 1,000-kw. generator driven by a mixed-pressure turbine. Most of our auxiliaries are steam-driven, although for purposes of heat balance some have been changed to electric drive. Two large air compressors furnish compressed air.

Water, at the rate of about 2,000 gal. per minute, is pumped at 100 lb. pressure by both electric motor and steam-turbine driven centrifugal pumps. A turbine-driven booster pump of 500 gal. per minute capacity furnishes water at 250 lb. pressure. Hydraulic pressure of 1,000 and 2,000 lb. pressure is furnished by reciprocating pumps.

It will be apparent, considering the diversity of type and number of units, that conditions of operation, if not controlled, would lead to confusion and could be very uneconomical. But, on the other hand, this diversity and number of units when operated in proper combination permits an ideal heat balance and allows the entire power plant to furnish economically the various kinds of power. Most of our electric power house equipment is old and would be considered obsolete, but still our cost of power compares favorably with the cost of purchased power. Most of the credit for low cost of power is due to systematic scheduling.

The problems and solutions encountered each day led to a system of management which, besides eliminating trouble, has saved thousands of dollars, and has helped in many ways to lighten the burden of at least one engineer.

Primarily, the duties of the plant engineer are to see that the plant as a whole operates as smoothly as possible, and to do this with the least possible expenditure of money. This means that there must be but few delays due to installation or maintenance of machinery or equipment. Proper temperature and lighting must be maintained; buildings, yards, tracks, etc., must be kept in order. Power of various kinds must be furnished, and its proper and ecnomical use by the production departments must be directed. Besides, some time must be spent daily in conferences with production department executives on special problems upon which the advice of the engineer is desired. The activities of perhaps 100 mechanics in the various mechanical shops must be di-

rected efficiently. Due to the duties outlined above, together with the time spent on improvements, layout and design of new equipment, attention to serious breakdowns, etc., the plant engineer seldom has much time to devote to actual operation of the power house.

Management of the power house, however, does not mean that the plant engineer shall necessarily spend hours each day in the power plant, but rather that he shall provide himself with means whereby his time in the power house may be a minimum, but still the operation be kept reliable and economical. With the following system one hour daily of the plant engineer's time should suffice to keep him informed on all major questions relative to the power house.

A daily schedule of operations should be in use in every manufacturing plant, and from this a schedule of power requirements can be made up by the planning department in a very short time. This is done in this plant, and two copies of the power requirement schedule are delivered to the plant engineer at 4 p.m. each day. This schedule covers the expected time of operation of all major machinery for the next 24-hr. period from 7 a.m. on the following day. The plant engineer should have available the power requirements of each machine, and with this information a clerk can plot the power load for the power house. Boiler load is plotted from power house load added to factory load as shown by schedule.

Two copies of the daily estimate of power consumption, Fig. 4, covering the requirements of the factory for the 24-hr. period starting at 7 a.m. on the following day are received by the plant engineer at 4 p.m. daily. The engineer checks this sheet and assures himself that the machines required are ready for operation, or if not, and cannot be made ready when desired, or if it is advisable to shut down any machinery, he notifies the planning department and makes proper notations or changes on the schedule.

This schedule is passed along to the engineer's clerk, who checks each item against the figures which have been set up showing the power requirements of each machine, and the amount of power each machine uses per hour. The power is totaled for each hour and plotted on the estimated power load form, Fig. 1. One copy of each of these forms is delivered to the chief operating engineer, who arranges the number of boilers and other units to be used the following day and leaves the schedules on the watch engineers' desk for their information. The other copy is posted in the mechanical shop office, where all mechanical foremen refer to it and make their plans conform with it. This requires less than an hour's time, and everyone concerned knows before he leaves the plant just what is expected to be in service the next day.

A chart showing the economical operation of equipment in the power house, Fig. 2, is posted in the power house, which shows the watch engineers the units to use for any given load to obtain economical plant operation. When the watch engineer follows this chart he knows just what results are being accomplished at all times, and is therefore relieved of all worry or doubt regarding economy, and can devote his whole attention to the proper operation of the machinery.

The watch engineer on duty in the power house now has a guide to the day's requirements, and by reference to the estimated load sheet, he can figure out from the economy chart just what units he should have in operation at all times. The guesswork has been removed; in its place is a clear picture of the day's operation, which allows him to be prepared in advance for the expected load, instead of waiting until the voltage drops to get another unit into service. This saves much wear and tear on the machinery as well as on the operators.

The power house log, Fig. 3, has been designed to give the plant engineer all of the essential facts about the operation of the power house, and at the same time to

Form 1233

TIME	ELECTRIC POWER						
	D.C. Voltage Volts	D.C. Load Amperes	Unit No. 1 Amps.	Unit No. 2 Amps.	Unit No. 3 Amps.	Unit No. 4 Amps.	Unit No. 5 Amps.
7:00 A.M.							
7:30							
8:00							
8:30							
9:00							
9:30							
10:00							
10:30							
11:00							
11:30							
12:00 Noon							
12:30 P.M.							
4:00							
4:30							
5:00							
5:30							
6:00							
6:30							

D. C. POWER METER
Today 7:00 A. M. ..... K.W.H.
Yestdy. 7:00 A. M. ..... K.W.H.
Generated 24 Hrs. ..... K.W.H.

D. C. LIGHT METER
Today ..... K.W.H.
Yestdy ..... K.W.H.
Used ..... K.W.H.

Fig. 3—Powerhouse log used by the Republic Rubber Company

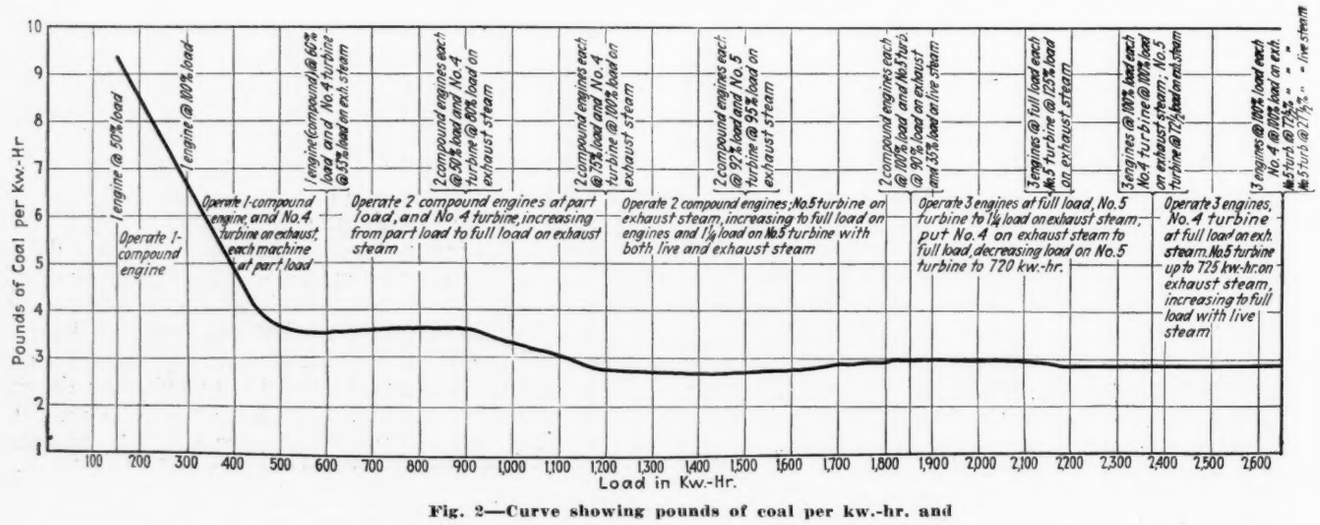

Pounds of Coal per Kw.-Hr
Load in Kw.-Hr.
1 engine @ 50% load
1 engine @ 100% load
Operate 1-compound engine
Operate 1-compound engine, and No.4 turbine on exhaust, each machine at part load
1 engine compound @ 60% load and No.4 turbine @ 63% load on exh. steam
2 compound engines each @ 50% load and No.4 turbine @ 60% load on exhaust steam
Operate 2 compound engines at part load, and No 4 turbine, increasing from part load to full load on exhaust steam
2 compound engines each @ 75% load and No.4 turbine @ 100% load on exhaust steam
2 compound engines each @ 92½ load and No.5 turbine @ 95% load on exhaust steam
Operate 2 compound engines; No.5 turbine on exhaust steam, increasing to full load on engines and 1¼ load on No.5 turbine with both live and exhaust steam
2 compound engines each @ 100% load and No.5 turb @ 90% load on exhaust and 35% load on live steam
3 engines @ full load each No.5 turbine @ 125% load on exhaust steam
Operate 3 engines at full load, No.5 turbine to 1¼ load on exhaust steam; put No.4 on exhaust steam to full load, decreasing load on No.5 turbine to 720 kw.-hr.
3 engines @ 100% load each No.4 turbine @ 100% load on exhaust steam; No.5 turbine @ 72½ load on exh. steam
3 engines @ 100% load each No.4 @ 100% load on exh. steam, No.5 turb @ 72½ - - - live steam
No.5 turb @ 27½ - - - -
Operate 3 engines, No.4 turbine at full load on exh. steam, No.5 turbine up to 725 kw-hr. on exhaust steam, increasing to full load with live steam

Fig. 2—Curve showing pounds of coal per kw.-hr. and prime movers in service at various plant loads

Form 497

Estimate of Power to be used from ..... A.M. to ..... P.M. Date .....

DEPTS AND MACHINES	DAY A. M.	DAY P. M.	NIGHT P. M.	NIGHT A. M.	TOTAL HRS.
WASHING DEPT					
No. 1 Mill Unit Mills					
Dryers					
MIXING DEPT.					
No. 1 Mill Unit Mills					
No. 3 Mill Unit Mills					
No. 4 Mill Unit Mills					
No. 1 Refiner					
No. 2 Refiner					
Strainer					

DEPTS. AND MACHINES	DAY A. M.	DAY P. M.	NIGHT P. M.	NIGHT A. M.	TOTAL HRS.
COTTON HOSE					
Looms					
Heater					
Curing Table					
Expander					
BELT and PACKING					
Press					
24" Press					
No. 1 Pot Heater					
No. 2 " "					
Cameron Machine					

REPUBLIC RUBBER COMPANY

POWER HOUSE LOG

DATE .....

INDICATED VACUUM No. 4 Ins. Hg.	INDICATED VACUUM No. 5 Ins. Hg.	Barometer Ins. Hg.	CONDENSER WATER DEGS. FHT. Unit No. 4 Intake	Unit No. 4 Discharge	Unit No. 5 Intake	Unit No. 5 Discharge	COMP. AIR Pressures Line Lbs. Sq. Inch	Receiver	STEAM Line Pressure Lbs. Sq. Inch	Back Pressure Inch	Meter No. 1 Reading	Meter No. 2 Reading	Meter No. 3 Reading	Meter No. 4 Reading	Meter No. 5 Reading	Meter No. 6 Reading	REMARKS

CURRENT COMMENT

Flexibility of Plain and Creased Pipe Bends

IN THE Oct. 20 number was an article titled "Flexibility and Plain and Creased Pipe Bends," by A. M. Hauser and S. Hirschburg. I take exception to some of the statements made therein and to the equations given.

The article, of course, pertains mainly to creased bends, a recent product which I have had no occasion to use and therefore have not investigated. But in 1924 I was compelled to investigate plain expansion bends mathematically, and found the following facts:

An expansion bend is usually a combination of circular arcs, and the force is always applied either tangentially

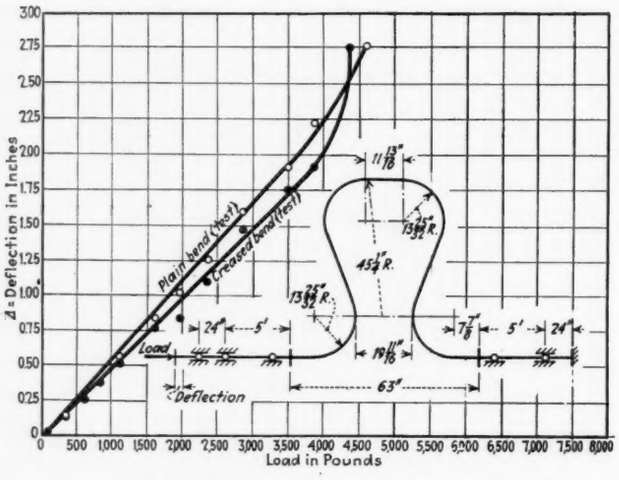


Fig. 1—Load deflection curves shown in Fig. 4 of the article

or radially. Circular arcs before bending remain circular arcs after bending. These are the properties of helical springs, and in developing the pipe equation the helical spring equations were arrived at. The helical action is clearly shown in the loop bend. The results obtained by using these equations were compared with the complete and detailed tests made by the Crane Company in 1916 or 1917 and found to check. I have since used them in designing large steam piping layouts with good agreement with the actions of the piping system in service.

The statement in the original article that the maximum stress always occurs at the top of a double offset bend is not correct. The maximum stress occurs in the arc having the larger radius.

The statement that the stress in the straight part of a straight yoke offset bend (Fig. 4 of the article and reproduced herewith as Fig. 1) is greater for a given force F than for Fig. 5 (Fig. 2 herewith) is also in error. The stress is not changed by connecting or inserting a straight yoke.

The expansion bend (Fig. 2) has been and still is considered an ideal expansion bend, but it is a mistake. An ideal expansion bend creates no lateral forces or deformation in the line to which it is coupled.

To avoid using too much space here, I refer to my article on expansion bends for high-pressure and superheated steam published in the May, June and July num-

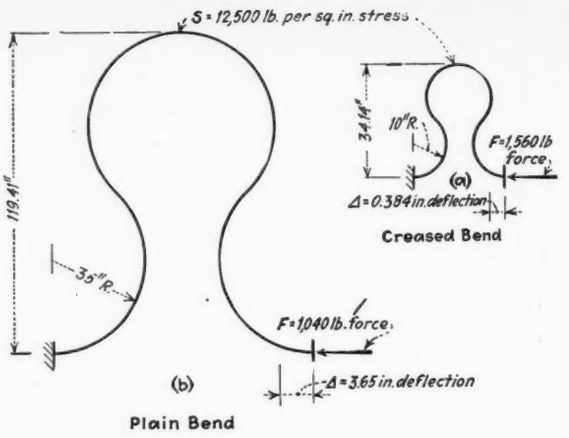


Fig. 2—Standard plain and creased expansion bend shown in Fig. 5 of the article

bers of *Blast Furnace and Steel Plant*, where those interested will find the application of above formulas and stress and shear diagrams given for all practical combinations of expansion bends. These equations are much simpler and more correct than those in the article under discussion.

The general equation for deflection is $\frac{d^2y}{dx^2} = \frac{M}{EI} = \frac{1}{R}$ for any method of support, any method of loading, any shape of beam; in this R is the radius of curvature.

Pittsburgh, Pa. PHILIP M. GALLO.

Moving Coal Cheaply From Dock to Car

ATTENTION has been called to an error appearing in my article under the above title in *Power* of Nov. 3, 1931. The fixed charges per ton as computed in the article should have been $0.073 instead of $0.0073. Possibly the real error was made in trying to include fixed charges per ton handled in this total cost. The useful figure is the total investment. Illustrating, to handle 500,000 tons, which the present investment is capable of doing, would reduce the fixed charges per ton more than one-half, whereas the labor charges per ton would change but little.

Within the company the individual performance of each plant is compared by using the combined cost of operating and maintenance expense, which at the present time is nearly 2c. Fixed charges will vary greatly according to each particular location and reflect natural conditions that are present, such as depth of water in which the dock is built, dredging possibilities, etc., whereas operating and maintenance expense form a more comparable basis and involve to a much greater extent the human equation. The following are the actual 1930 figures for drag-line operation at the Marysville plant:

		Per Ton
Operating labor (1930)	$1,573.36	$0.0092
Maintenance (labor and materials 1930)	2,112.68	0.0069
		$0.0161

Detroit, Mich. J. R. JAMES.

▼

HIGH flue gas temperature may be caused by soot on the outside of the boiler tubes or scale on the inside water surface, poor water circulation, after burning of the combustion gases, broken or leaky baffles and high excess air.

Diesel Fuel-Injection Principles

THE ARTICLE "Are Diesel Fuel-Injection Principles Wrong?" together with a letter by Edward Adams Richardson concerning the amount of excess air, in *Power,* Dec. 1, bear strongly on the question of injecting the fuel in the vapor or the gas rather than in the liquid state.

Since this idea is one of the first to arise when an engineer becomes aware of the obstacles to obtaining even an approach to mechanical vaporization, it seems strange that the problems of injecting fuel in the vapor state, at least for the common-rail system, have not been more conclusively attacked. What are the causes of this apparent oversight?

First of all may be presented the dearth of such knowledge of the physical and chemical properties of liquid fuels as would inspire and aid the mechanical engineer in the solution of such problems. If all we knew about water was that it will boil and the resulting substance expands and condenses, our giant steam-electric power houses would not be in existence. The complexity of those compounds which we call liquid fuels is a common excuse given for this absence of information regarding the properties of these substances. We surely cannot proceed far in excellence of utilization of substances of which we know so little.

It is likely that the statements originating in Germany to the effect that vaporization seems to play no part in ignition and combustion in oil engines may prove a retarding influence for many years on oil engine development, just as in Germany the development of airless injection was retarded for many years by the one-time dogmatism broadly proclaimed there that the only way to operate an oil engine was by the method of Dr. Diesel.

When the above statements concerning combustion are presented to physicists they frequently simply remain silent. The highest recorded thermal efficiency, as we recall, has been obtained with *gaseous* fuel in an engine of about truck or railcar size. The highest mean effective pressure has been obtained with a carburetor engine, which means with a light fuel and where time is available for at least considerable vaporization. The highest revolutions per minute, that of outboard motors, has been obtained with engines using gasoline, a light fuel. To this evidence of the value of vaporization Mr. Richardson adds simple and clear mathematical proof.

It would seem evident, therefore, that when some researcher says vaporization plays no part in ignition and combustion in oil engines, such a person is referring to a condition of fuel oxidization with which the real oil engine developer is not concerned. For the available evidence seems, at present at least, to suggest that the most widely satisfactory path of fuel oxidization in engines is by way of the vapor, or of the gas, phase. Perhaps there are as many paths for oxidization as there are hydrocarbon compounds; but how many of these are vital to engine operation? For us one sun is more vital, apparently, than the Milky Way.

As the article in *Power* questions, How is the heating of the fuel prior to injection to be accomplished? This raises the suggestion that *Power* publish some data on critical temperatures of oil fuels. Since these fuels are highly complex, perhaps both minimum and maximum critical temperatures are involved, occurring and varying according to the character of the fuel components. And it may be of concern whether anything unfavorable may occur to the fraction having the lowest critical temperature when it is raised to, and, for practical reasons, above, the critical temperature of the component having the highest critical temperature.

Some of the desirable data for this problem would be: critical temperature, critical pressure, total heat content, specific heats, and specific volume. And possibly the lubricating value of gasified oils might interest designers of injection control apparatus.

This looks like a suitable research program for a small college laboratory. The death of Edison has added to the cry that today research work can be done only in great corporation laboratories. In their difficulty in obtaining genuine research minds, that conception of the path of achievement is what those in control of some great laboratories would like to have the inquiring mind believe. And if the information needed by mechanical engineers is to be left to the directors of a few huge research concentration camps, we may as well at once be ready to accept defeat. The placing and direction of such research should be executed with considerable caution and judgment.

This is the age of chemists, but when it comes to consideration of injection principles we find that not only are possible findings of the physicists not available for our guidance, but the mechanical engineer is supposed to provide means for meeting the peculiarities of an arbitrarily provided fuel by using a drop-by-drop method when, on the other hand, perhaps the chemist could change the entire engine digestive necessities by a method which deals with tank-car quantities. Control of the fuel characteristics as well as the engine characteristics should be at our disposal.

As suggested in *Power,* the fuel could be heated by electricity. Unfortunately, where this method could be applied most favorably such heating is least essential to insure satisfactory combustion conditions. In some fields one advantage of a compression-ignited engine is that it eliminates electrical requirements. Where storage batteries would be needed the amount of electrical energy required for heating the fuel might be an undesirable item. The total heat of the fuel to be stored in one pound would probably be considerably more than the heat of vaporization, which, as we recall, would be around 50 B.t.u. Some correct figures might be of interest.

Mr. Richardson says, "The amount of excess air can be reduced if we can secure complete combustion in the time available." That time factor, at present, divides somewhat sharply high-speed and low-speed operating conditions. Early high-speed oil engines were attempted miniatures of large engines. These miniatures failed. But there was and still is a common bond between large and small engines. Of present-day engines, those using compression-ignition have, thermodynamically, the greatest promise. If we can but get more light on the solution of high-speed problems, our great engines may yet, in some measure, be patterned upon small-engine progress.

Combustion should be controllable within the narrowest possible limits, with consideration given to both crank travel and absolute time. This statement suggests the important part which may be played by mastery of vaporization processes.

ROBERTSON MATTHEWS.

Bolton, Ont.

The Future Cost of Power*

STEAM-POWER plants can be built today for given steam pressures at a lower total cost than for many years. The actual investment that may be justified depends upon the cost of fuel and the annual use factor of the system. In general, with $5 coal and 40 per cent annual load factor, station costs will now range from $75 to $80 per kilowatt of capacity as against $100 per kilowatt ten years ago. In a plant of 100,000 kw. capacity this represents a decrease of at least $2,000,000 in investment, and with fixed charges of 14 per cent a year a saving of at least $280,000 annually. With 40 per cent annual load factor this represents an average minimum decrease in cost of 0.8 mill per kilowatt-hour. As rates are now set up, this would result in a reduction of rates to the large power consumer of about 0.5 mill, while the rate to the domestic consumer who uses 400 kw.-hr. per year per installed kilowatt could be reduced about 6.5 mills, due to the large share of his cost which is fixed by demand charge.

Outdoor Power Plants

There is considerable talk about outdoor power plants. This is already an accomplished fact with certain electrical equipment. Some hydro-electric plants have been built with the turbines and generators lacking the usual plant inclosures. These units are protected from the weather by suitable sheet-metal framed covers.

When one considers the possibilities of a steam boiler and turbine in the open, certain operating difficulties present themselves. Climatic conditions, the necessity of periodic opening of machines for repairs and inspection under all conditions of weather, and the exposure of the necessary operating and repair forces to severe temperature changes, present substantial objections to the outdoor station. In any case the massive foundations for boilers, turbines and condensers, the intake and discharge water tunnels, the structural steelwork to support the boilers and their auxiliaries and to carry the turbine room crane, and the necessary space for laboratories, control rooms, repair shops, dressing rooms, and executive offices, all form a substantial portion of the present cost of a power station. Coal storage is already placed outside some of the newer stations. The saving from omitting the remaining parts of the present superstructure would not be large in dollars per kilowatt of capacity and would be offset by increased costs of operation and maintenance.

It is becoming evident that in the future certain social demands may be made upon the utilities. All will agree that pure air and a clean atmosphere are highly desirable in every city. To attain these conditions the flue gases from coal-burning stations would have to be washed and otherwise purified before being discharged. This appears to require quite an elaborate plant and expensive construction, the costs of which may offset any further cost reductions in other portions of the plant. Consumers will have to pay in their rates the charges on these purification systems.

There is the further element of taxes. Lawmakers find that the utilities are easily taxable because these taxes are readily passed on to the consumers. Taxes on electric utilities appear to have increased in late years in a greater ratio than load, and if this continues taxes will tend to prevent further reductions in power rates.

When power can be secured from hydro plants on large rivers with constant flow, such as the Niagara or the St. Lawrence, or where flows can be controlled from low-cost storage, cheap water power is a possibility. When plants are located upon variable-flow rivers, which is the usual case on the Eastern seaboard, additional capacity must be installed in steam plants to carry the load in low-water periods. The added fixed charges on the steam plant and its cost of operation increase the cost of water power in such cases. Large hydro-electric plants to use variable run-of-river are generally warranted only when a large power system can absorb into its normally steam-supplied load all the power that may be developed at all stages of river flow. Hydro-electric energy will not therefore, in the average case, necessarily tend to lower the cost of power.

Interconnection

Interconnection of large systems enables the various companies to carry less stand-by plant. This lessens plant investment and thus lowers power costs. Reduced costs of distribution systems may be achieved through standardization on a single frequency, through wider use of high-tension feeders, and through the employment of standardized house installations. Here again the public demand for underground distribution imposes an added burden upon the utility which offsets some of the above savings.

Load Factors

Some interesting deductions may be drawn from a study of the load-duration curve in Fig. 1 for a station with a peak load of 200,000 kw. The annual load factor for the whole station is 51.4 per cent. Let us assume that a certain portion of the plant with 40,000 kw. capacity is used only to carry the upper 20 per cent of the peak load, which lasts for about 300 hr. per year. The annual load factor for this portion of the plant is only 1.7 per cent. Let us further assume that this plant cost $90 per kilowatt, that fixed charges are 14 per cent per year, that 13,200 B.t.u. coal costing $4 per ton is used, and that the station heat rate can be represented by the formula B.t.u. per kilowatt-hour =

$$\left(13{,}600 + \frac{100{,}000}{\textit{Annual load factor in per cent}}\right)$$

If this peak load plant of 40,000 kw. is only operated and on stand-by for three months during the winter load, its load factor for that period will be equivalent

FACTORS AFFECTING FUTURE POWER COSTS

1. Decreases in the unit costs of constructing power stations and distribution systems lead to lower fixed charges, which, in turn, result in lower power costs. Steam station costs cannot, however, be greatly decreased below present figures.

2. Little hope of decreased power costs may be expected from outdoor power stations.

3. The cost of eliminating smoke and dust from flue gases, the use of underground ducts for distribution systems and other expenses to meet social demands, together with the increasing burden of taxes, offset savings produced by engineers in other elements of cost and tend to maintain high rates for electric service.

4. Future developments of water power on the variable-flow rivers of the Eastern seaboard necessitating supplementary steam stations will not appreciably lower power costs.

5. Interconnection of large systems, when properly accomplished, will lower investment in reserve plant and tend to lower power costs.

6. Reductions in power costs to domestic consumers will come through increased use by each customer of his present demand, thereby increasing his own as well as the system's load factor.

7. Commercial power costs are more affected by the factors noted above, such as lower first cost of plant and by interconnections as well as by economies that may be effected in the operation of the plant. Decreases in costs resulting from these factors will tend to lower rates upon commercial power. Also, improved system load factors decrease the cost of commercial power.

8. Study of system peak-load problems may lead to lower station investment and thus to lessened power costs.

9. Savings may still be expected from decreased operating costs through less fuel consumption by the use of more efficient plant or by the employment of higher steam pressures and temperatures or of binary cycles. The more extended use of fully automatic equipment in plant appears to also lower production costs.

10. Commercial expense may be lessened by standardization and simplification of the company's organization, and the careful control of all these overhead charges.

*From an address by Prof. A. G. Christie, Johns Hopkins University, Baltimore, before the Baltimore section of the American Society of Mechanical Engineers, Nov. 17, 1931.

to an annual load factor of 6.8 per cent. The cost per kilowatt-hour delivered on this peak load after allowance for labor and maintenance will be 9.04 cents.

The annual load factor for that portion of the load below 160,000 kw. is 63.8 per cent. If the same unit cost of station, rate of fixed charges, fuel costs, heat rate, and labor and maintenance allowances are made for this portion of the plant as for the peak portion, the cost per kilowatt-hour becomes 0.522 cents.

Finally, if it were possible to operate the whole plant on a 100 per cent load factor it would be possible to generate power for about 0.44 cents per kilowatt-hour. The average cost of power of the whole plant of 200,000 kw. capacity

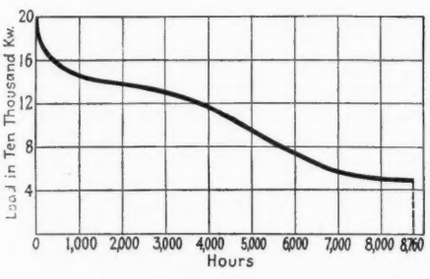


Fig. 1—Load duration curve; 51.4 per cent annual load factor

at the annual load factor of 51.4 per cent with the same assumptions as before figures 0.58c. per kilowatt-hour. Thus a decrease of 10 per cent in the cost of power can be achieved if the annual load factor can be built up from 51.4 to 63.8 per cent, and 24 per cent decrease in cost if 100 per cent load factor could be secured. This further demonstrates that increased load factor is one of the most important elements in reducing power costs.

How can annual load factor be increased? This involves building up the daily load curve and eliminating the seasonal fluctuations in demand. Daily load factors can be increased by increasing night loads through the use of power in certain intermittent electro-chemical processes, by encouraging the night operation of factories through inducement rates, and by developing the use of off-peak power for commercial uses. Peaks can be kept at a fixed amount by adding interruptible power loads at an attractive rate.

Building Domestic Load

The load factor of domestic service can be improved through the more widespread use of labor-saving devices. The diversity in the use of this equipment causes consumption of power at other periods than the normal lighting peak, and this greatly improves the average load factor not only of the domestic consumer but of the system as a whole. During the depression, the domestic loads have been well maintained and have been the main source of the utilities' revenue. The commercial power loads, which are often served on a narrow margin of profit, have slumped badly and have shown poor earning capacity under present conditions. Hence the future field for power development should be the constant domestic load rather than the variable commercial power loads.

What are the possibilities of providing for the peak load portion by a plant of minimum cost? This subject was fully discussed by the writer in two previous papers, where the economies of serving the whole or a portion of the peak by steam or water accumulators were fully analyzed and the possible savings appraised. Consideration was also given to low-cost steam plant for peak-load service only and to the use of diesel engines. These discussions indicated possible reductions in power costs by the use of such special peak-load plant.

Much attention has been given to the development of base-load plants for the lower portion of the load-duration curve. The economics of steam cycles for both higher pressures and higher temperatures have been fully analyzed, and the possible savings are known. The economy in fuel from the use of such cycles may be offset by the increased investment for such high-pressure and high-temperature plants. When ample base loads can be allotted to such a plant, their construction becomes economically justified.

Much publicity has been given to the development of the mercury steam cycle. At the present moment, this appears to be economically justifiable only for base-load service where fuel costs are comparatively high. The higher the fuel costs and the greater the annual load factor of the system, the greater will be the economic justification for the mercury steam cycle.

Operating Costs

Fuel costs will decrease only slightly with increased load factors. Labor costs per kilowatt-hour tend to decrease with increased load factor, but not in the same proportions to the decrease in fuel costs. Maintenance costs per kilowatt-hour decrease even less than labor costs with increased load factors. Coal consumption per kilowatt-hour in the newer central stations ranges from 1 to 1¼ lb. per kilowatt-hour. With $4 coal, and 1 lb. per kilowatt-hour, the total fuel cost is only 0.2c. per kilowatt-hour. It is not probable that this can be reduced to less than 0.6 lb. per kilowatt-hour by any known cycle, even by the mercury steam cycle. This

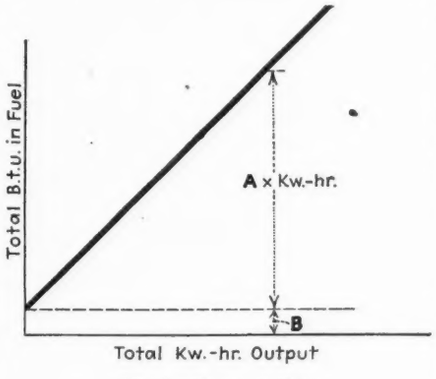


Fig. 2—Parsons line

maximum reduction in fuel would reduce power costs only 0.08c. per kilowatt-hour. This reduction is of significance to the commercial power user, but has little effect on the cost of domestic power. Automatic equipment replacing labor is being introduced steadily into our power stations. Savings from its use must greatly exceed the increased fixed charges on its first cost to produce noticeable decreases in power costs.

No-load Steam Consumption Should Be Studied

There remains one other element in the cost of generating steam power to which attention should be directed. Station performance can be approximately represented by the so-called "Parsons" line, as in Fig. 2. The fuel consumption as represented by this line can be broken down into two components, the constant no-load heat consumption B and the variable element $A \times$ *kilowatt-hours*, which varies directly with the output. A appears to be fixed by the particular heat cycle of the plant. The no-load heat consumption B is made up of the requirements of the main unit when operating fully excited at speed but with no load, of radiation losses throughout the plant, of certain energy requirements for turbine and boiler auxiliaries and of other losses. This element A has a major influence on the total fuel requirements at all loads. The no-load steam consumption of all plants should therefore be given the closest study, as any substantial reduction in its amount will lead to lower power costs at all loads. The study of the component elements of the factor B is a pressing problem in power house operation and in the design of new plants.

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California Plant Gets "Power-Factor Rate"

A plant for the production of nitrogen and fertilizer has recently been placed in full operation near Pittsburgh, in Contra Costa County, Calif., by the Shell Union Oil Corporation. Power is supplied to the plant by the Pacific Gas & Electric Company at what is called the "power-factor rate." The oil company takes power at 60,000 volts, leases a transformer bank from the power company and is responsible for all electrical service in the plant inside the 60,000-volt terminals.

At present the power factor is about 99 per cent, and the oil company is penalized in the event that the power factor drops off. During September, the first month of full operation, the maximum demand for the plant was 3,700 kw. and the total power consumed was 2,352,000 kilowatt-hours.

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An article entitled "The Right of an Industrial to Sell Power Without Becoming a Utility," inadvertently listed on the contents page of a few copies of this number of *Power*, will appear in a future issue.

READERS' PROBLEMS

Conducted by L. H. MORRISON

OPERATING HEATING SYSTEM—*We have a heating system of 2,500 sq.ft. of radiation, using two fire-tube boilers alternately, which generate steam for the above amount of radiation and also for a 500-gal. hot-water heater. The boiler is set at 1 lb. and an oil burner is used. The vacuum pump is set at 8 in.; the hot water heating valve shuts off when the water reaches 156 deg. When the boiler shuts off it starts to create a vacuum in the drum, to as high as 10 or 12 in. This shuts off the hot water heater, that is, it starts to pull a vacuum in the trap to the boiler side instead of to the pump, until we break the vacuum in the trap, whereupon we get a 1 lb. pressure back on the boiler.*

Is 1 lb. enough for this amount of radiation and to heat 500 gal. of water per hour? How does such a high vacuum get up in the boiler drum. Could a trap at the end of the heating main blow through and cause this? W.J.C.

If you will send in a sketch showing how trap is hooked up and where the pump is located an answer will be given. In the meantime it can be stated that when the oil burner control shuts off the burner the boiler continues to give off steam at a falling pressure until, as you say, a 10-in. vacuum exists in the boiler drum.

Readers, in writing about these problems, should give their names and addresses to enable the editor to write them when more information is needed.

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STAGE FEED WATER HEATING—*We have a 400-hp., cross-compound, non-condensing engine using 150 lb. steam pressure. The intermediate receiver pressure is 30 lb. and the exhaust pressure is 1 lb. We require about 8,000 lb. of feed water, which is now heated to 200 deg. F. in an open type feed-water heater. There is considerably more exhaust steam available for this purpose than is necessary.*

Would there be any gain in over-all plant efficiency if we would bleed about 500 lb. of steam per hour from the intermediate receiver at 30 lb. pressure and heat this feed water to 260 deg. F. in a closed feed-water heater?

Is it ever advisable from an over-all efficiency standpoint to heat feed water with steam above atmospheric pressure when there is plenty of atmospheric exhaust steam available? It is assumed that this steam is bled from a prime mover for this purpose only. P.M.K.

There is a gain in over-all efficiency if steam is bled at some pressure above atmospheric to heat feed water, provided that the feed water has already been heated to the maximum temperature possible by exhaust steam, about 200 deg. with zero gage steam. The actual saving depends upon the engine's thermal efficiency.

POUNDING IN AMMONIA COMPRESSOR—*The suction line and the suction valve of our double-acting ice machine often frosts and the compressor pounds. Pinching down on the expansion valve does not help, as the supply of ammonia becomes too little. What can be done?* J.W.D.

The frosting indicates that some liquid ammonia is going through the suction line into the compressor. The pounding is due to these slugs of liquid. Pinching down on the expansion valve will reduce the liquid level in the coils and so cause only ammonia gas to reach the compressor. If, however, the coils are insufficient, this reduced amount of ammonia may seriously decrease the coil output.

It would be worth while to install a float control so that the liquid level would be maintained constant without hand regulation.

RUST REMOVER—*What can be used to remove rust from finished surfaces of engines and other plant equipment?* O.P.

An economical rust remover may be made easily of ingredients to be found in any drug store. The composition is: 3 oz. petrolatum, 2 oz. light spindle oil, and 6 oz. tripoli.

The oil and petrolatum are steamed together until they are warm. Then the tripoli is added and the mixture stirred until it is smooth. When spread on rusty parts and rubbed off with a cloth, this mixture will remove the most stubborn coat of rust.

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SUPERHEATED STEAM FROM BOILER—*Is steam from a vertical boiler in a superheated condition?* R.C.H.

Certain types of vertical boilers, where the upper tube ends are dry, do deliver steam slightly superheated, but the action is insignificant compared to the action in a superheater. One should not expect the steam to be more than dry and the danger of burning the exposed tube ends, or the rivets in the thimble of a submerged-tube boiler, should not be ignored.

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Keeping a Grill Room Cool

THE QUESTION

THE GRILL ROOM of our hotel is located in the basement, and even in winter there are complaints about the warm atmosphere.

Two suggestions have been made. One is to install unit coolers along the side walls and cool with brine from our refrigerating plant, which could not carry the load save by the addition of new equipment.

The second suggestion is that we install a system of air ducts and cool this air by the spraying of water previously chilled in a cooling chamber filled with ice and provided with coils through which the water would circulate. We can buy broken and discolored ice for $3 a ton. E.M.J.

SATISFACTORY COOLING of the dining room could undoubtedly be secured by either the unit coolers or the ice and air duct system suggested. The problem, therefore, is to decide which will prove the more economical when fixed charges on the investment and operating costs are considered for each system.

If the ice and air duct system is used the first cost will be comparatively low. But the operating cost per ton of refrigerating effect will be $3, since this is the price to be paid for ice.

I recommend the alternate scheme of using unit coolers, each refrigerated by a water spray. This water should, in turn, be cooled in a separate tank or cooler refrigerated by a small self-contained, automatic, electrically driven ammonia compressor. Since additional equipment is required anyway, the installation of a separate system for air cooling would cost little more than would an addition to the present system and would at the same time make it possible to take advantage of a high suction pressure in the air cooling system.

If it is desired to have the air leave the coolers at, say, 70 deg. F, an initial temperature of around 60 deg. for the cooling water and a temperature of about 50 deg. for the refrigerant in the coils of the cooling tank may be assumed. This corresponds to a suction pressure of 74.5 lb. gage. If an average condensing temperature of 80 deg. be taken and a 5 lb. excess head pressure due to foul gases be allowed, the compressor will operate at a head pressure of 143.3 lb. gage.

The calculated theoretical indicated horsepower for these conditions is 0.304 per ton of refrigeration. For a small unit at this high back pressure the volumetric efficiency would be 80 per cent and efficiency of the motor and the compressor 80 per cent. The input horsepower would be

$$\frac{0.304}{0.80 \times 0.80}, \text{ or}$$

0.475 hp. per ton of refrigeration. The horsepower-hours per ton of refrigerat-

ing effect would be 24 × 0.475 = 11.4. The electric power consumption would be 0.746 × 11.4 = 8.5 kw.-hr. per ton of refrigerating effect. At 2c. this would amount to only 17c. per ton of ice equivalent. Even after water costs and maintenance costs for the mechanical cooling unit are taken into consideration the cost of operation would be far less than the $3 paid for ice. And since several tons of refrigeration would be required daily, the savings possible with this system will certainly bear investigation.

The small self-contained, automatic, electrically driven refrigerating unit recommended for this service may be secured from any one of several manufacturers at a comparatively low cost. Operating and maintenance troubles with such a unit are few and usually not expensive. I grant that the installation recommended would cost more than the ice cooling system mentioned in the question, but I believe the operating economies possible with the mechanical unit would more than offset this, especially since it is indicated that the apparatus will be used throughout most of the year. M. F. KNOY.

Beaumont, Texas.

A GRILL ROOM does not require continuous cooling, since it is usually in use for only a few hours each day. Addition of equipment to cool and circulate brine for use in unit coolers would be rather expensive and the unit coolers would also cost a considerable amount.

A duct system through which air can be distributed, combined with a spray cooler, has the advantage that the air is in circulation, odors and smoke are removed and fresh and recirculated air can be properly proportioned to give the most satisfactory atmosphere. Air can be cooled to 55 deg. by a spray, which, in turn, is cooled with ice. This cooled air can be mixed with the proper amount of fresh or recirculated air to give the room the proper temperature and humidity.

In many cooling systems using ice the discharge from the spray flows over broken ice and is cooled and recirculated in an open system, no cooling coils being required. Of course, if the ice is too dirty this may not be desirable, but it is possible to install a filter that will remove the objectionable impurities from the melted ice. A cooling system of this kind is not very expensive to install or to operate and is as easily regulated as any other. Since the probable period of operation is only a few hours a day, the amount of ice used is not large. The melting of 300 lb. of ice per hour will absorb the heat given off by 100 people. Allowing for another 300 lb. to counteract heat leakage, the total requirements would be 600 lb. of ice per hour, costing 90 cents.

W. H. MARTIN,
Professor of Heat Engineering,
Oregon State Agricultural College.
Corvallis, Ore.

IT IS EVIDENT that heat is being introduced into the grill room from some external source, probably from the kitchen. The simplest remedy for this condition would be to produce a positive flow of air from the grill room into the kitchen. Probably the best method of doing this would be with an exhaust fan of sufficient capacity with its inlet directly over the source of heat.

The fresh-air inlet to the grill room should draw clean air from the outside and should be arranged for diffusing the air evenly over the room so as to prevent strong air currents which might be objectionable in cold weather. Certainly with this arrangement the room could be kept cool enough during cold weather, and the use of a damper in the air inlet duct would permit adjustments over a considerable range.

In warm weather the use of an air washer with recirculated water in the fresh-air inlet will reduce the air temperature 10 or 15 deg. F. without the aid of ice or other refrigeration, depending on humidity conditions of the atmosphere.

The cost of operating a system as outlined would be only that of the motors driving the exhaust fan, the small water-circulating pump and the small amount of water for replacing that which is evaporated into the air. To compare costs of this and other systems more complete data must be known, but it seems certain that the above arrangement would be more satisfactory and more economical than cooling with ice or a mechanical refrigerating unit.

J. I. HUDSON.

Nashville, Tenn.

A Question for Our Readers

In our plant we have a double-acting twin 5 x 6-in. compressor, running at 190 r.p.m. The pressure to the condenser is 125 lb.; the suction pressure is 15 lb. The condenser is a double-pipe type, 8 branches 10 ft. long. The water enters at 47 deg. and leaves at 53 deg.; the receiver is 6½ in. x 6 ft.; the brine tank is 3.25 ft x 8 ft. x 4 ft., with one 252-ft. coil of 1¼-in. pipe. There is a pump connection to the tank for the service of a small refrigerator in the house. The pump's capacity is 50 gal. per minute. The temperature of the brine is kept to 10 deg. and return at 28 deg., and we are making 150 lb. of ice per day.

We have four rooms; the dimensions are: No. 1 room 570 cu.ft., in which the temperature is kept at 18 deg., with 220 ft. of 1¼ in. pipe; No. 2 room is kept at 30 deg. with 150 ft. of 1¼-in. pipe and has 190 cu.ft.; No. 3 room is 380 cu.ft., the temperature being kept at 40 deg., with 90 ft. of 1¼-in. pipe; No. 4 room is 343 cu.ft., the temperature being kept at 40 deg., with 75 ft. of 1¼-in. pipe. The rooms are 12 ft. from the compressor. The three expansion valves are placed in a header near the compressor, one for the tank, one for the No. 1 and 2 rooms and one for No. 3 and 4 rooms.

Our trouble is: We cannot get the frost back to the machine from Room 4. If we open the expansion valve wider we get the frost back from No. 4 room, but we do not get frost from No. 2 room. Only a few feet from one to the other frost; the rest of the pipe remains wet. What is the trouble? G.M.

Suitable answers from readers, if received promptly, will be paid for when published.

AN INEXPENSIVE form of vacuum refrigeration could be used to refrigerate the wash water of an air washer and at the same time it may be used to take some of the refrigerating load. In this form of vacuum refrigeration the wash water is sprayed into a tank in which a high vacuum is maintained by a small vacuum pump or an ejector. Part of this water that is sprayed flashes into vapor, taking the heat for vaporization from the remaining water. The cooling effect is instantaneous and large volumes of cold water may be had by this method. As an aid in this connection, an artesion well, if it can be located close to the surface, will yield a supply of water around 55 deg. F. If this water can be piped to the washer without too great a temperature rise, it often is found to be sufficient; if not, it may be sprayed into the vacuum tank.

One objection to ice, as suggested in the question, is the uncertainty of delivery in bad weather. With impassable roads, the delivery of ice would be no more certain than the delivery of fuel. It is possible to store a supply of fuel, but this is not so easily accomplished with ice.

WILLIAM ANDERSON.

Brooklyn, N. Y.

I SURMISE that this grill room is so located that the effect of any natural air currents is nil. The warm atmosphere is most likely nothing but stagnation or over-humidity. A ventilating system arranged to change the air frequenly and distribute it properly throughout the room might be the least costly and most satisfactory answer. Dehydration of the air through use of equipment using silica gel or activated alumina is also suggested.

Why the operators of eating places insist on purveying their wares from a hole in the ground, without regard for ventilation, is beyond me. I know of several "below-street-level" restaurants that are comfortable simply because of the elaborate ventilation and air-conditioning system used. In fact, such restaurants extol the merits of their atmosphere as much as the quality of their food. R. E. CRAMER.

Pittsburgh, Pa.

WHAT'S NEW IN PLANT EQUIPMENT

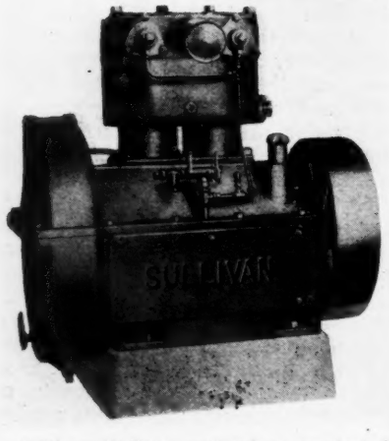
Ball-Bearing Vertical Air Compressors

RECENT ADDITIONS to its line of vertical single-acting compressors, in new models and new capacity ranges, are announced by the Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill.

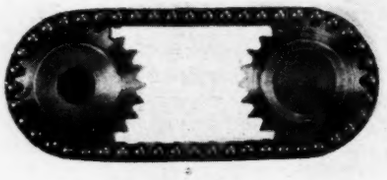
Comprising the new line are type WL-1 for flat and "V" belt drives and type WL-11 direct-motor-driven compressors. They are single-cylinder, single-acting units, with heavy-duty ball bearings on the crankshaft. The cylinder is cast separate from the frame, and the head, containing the inlet and discharge valves (of the "wafer" type) may be attached in any one of four horizontal positions, to secure convenience in piping connections.

These units provide displacement ranges from 27 to 67 cu.ft. per minute. Direct-connected units employ flexible external and internal gear couplings between the compressor flywheel and the motor shaft. "Sweep control" unloading system is employed, but automatic regulation of several types, including manual, semi-automatic, fully automatic start and stop control for both the belt and direct-connected units, can be furnished. These compressors are designed for pressure up to 125 lb. gage.

The WL-2 and WL-4 belt-driven vertical units are available in two-cylinder and four-cylinder models, respectively, and are similar to the direct-connected two-cylinder and four-cylinder units WL-22 and WL-44 already available. These units may also be driven by "V" belts. Capacities range from 119 to 348 cu.ft. free air per minute. The four-cylinder units are "V" type balanced design, the two pairs of cylinders being set at an angle of 90 deg., with a common crankshaft and only two cranks.



Sullivan WL-11 and WL-2 vertical air compressors



Link-Belt's miniature silent chain drive

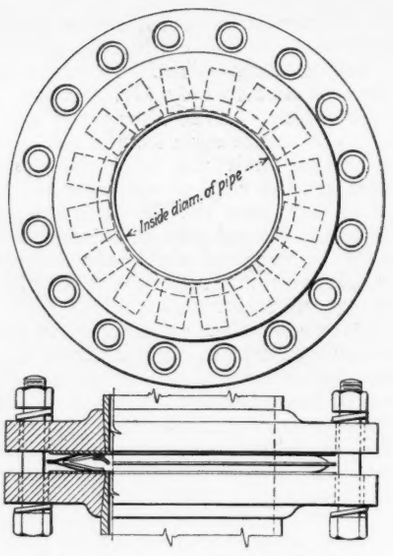
Silent Chain of 3/16-In. Pitch

A 3/16-IN. PITCH silent chain made in three types, middle-guide, side-flanged and duplex, is announced by the Link-Belt Company, 910 South Michigan Ave., Chicago, Ill. The middle-guide and side-flanged chains are used where all shafts are driven in one direction, and the duplex chain for reverse direction on a shaft or shafts, or where adjustment features are desired. An "X" type pin is a new feature of the chain joint.

Brought out to meet the growing demand for a positive, yet flexible, drive for fractional horsepower motors and units, this small chain already has proved successful as a transmission medium on such equipment as regulators, meters, oil burners and similar places where a small positive drive is necessary.

Gasket-Type Expansion Joint

A GASKET-TYPE expansion joint for use in pipe lines is now being put out by Thomas R. Heyward Company, Pittsburgh, Pa. A development from the Dennis turbine-condenser joints of similar construction, it consists of a bellows-type gasket filled with properly designed springs.



Dennis expansion joint for pipe lines

The joints are made to fit standard pipe flanges, the bolts of which use lock-type spring washers, and sufficient initial tension (cold) is produced to seal the joint. As the piping expands, the pressure on the gasket is increased, and the internal pressure also aids in sealing the joint. These gaskets are made in pipe sizes 3 in. and above for 125 lb. working pressure, and will take care of 1/4 to 3/8 in. expansion axially, or lateral movement of same amount. The bellows is made of Duraloy steel, with suitable gaskets attached.

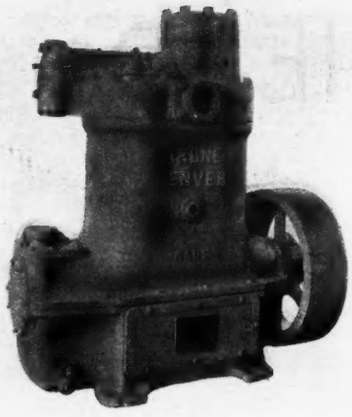
For turbine exhausts, any specified amount of down pull may be obtained by adjusting the flange bolts, or the adjustment may be set to allow complete balancing of only the internal spring pressure. When combined with a standard van stone joint it forms a swing-joint expansion element for use in heating risers and like applications.

The joints are installed similarly to ordinary gaskets. The flange bolts are pulled up tight, first compressing the joint to its limit, after which the nuts are backed off sufficiently to allow proper expansion space when the piping is heated.

Two-Stage Vertical Air Compressor for Pressures to 1,000 Lb.

GARDNER-DENVER COMPANY, Quincy, Ill., has developed a new type of two-stage vertical water-cooled air compressor intended for pressures up to 1,000 lb. It is made in a number of sizes, suitable for capacities of from 24 to 90 cu.ft. of free air per minute.

A feature of the new design is the combining of the low-pressure cylinder head, high-pressure cylinder and intercooler in a single casting. Through the use of generous-sized cored passages in the cylinder block and head, all outside air and water piping between the cylinders and to the intercooler has



Gardner two-stage air compressor

been eliminated, giving a symmetrical design that should do away with water and air leaks. The intercooler design has been reversed from former construction. Instead of the low-pressure air passing through tubes surrounded by water, it is the water that now passes through the tubes, which are expanded into steel header plates, so that the entire nest of tubes can be pulled out as a unit. More tubes of larger size have increased the cooling area and improved the volumetric efficiency.

Lubrication is by the force-feed system. Oil under pressure is piped to each main bearing and drilled passages in the crankshaft lead the oil to the crankpins, as in automotive practice. The pump is of the plunger type, with ball valves. It is driven by an eccentric in the closed end of the crankshaft.

The cylinder block and all power end details are similar to and interchangeable with the company's line of duplex vertical single-stage compressors.

Improved Insulation Support Holds Covering Concentric With Pipe

In conventional practice, pipe covering or heat insulation, hangs on the pipe. As time goes on the weight of the insulation plus the weight of accumulated moisture gradually causes the covering to sag away from the pipe at the bottom and pull thin on top.

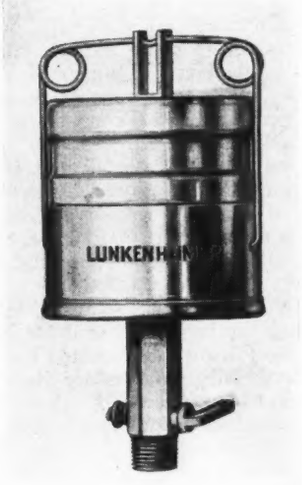
With a view to correcting this misalignment and distortion of the insulation, the American District Steam Company, North Tonawanda, N. Y., has developed an insulation support to hold the pipe covering concentric with the pipe.

With the new support, the covering is cradled in wide brass bands. Each band is hung from a saddle which passes through the insulation and rests directly on the upper surface of the pipe. This method of support keeps the insulation concentric with the pipe and prevents sagging, and the insulating efficiency is maintained. The insulation supports are available in all standard pipe sizes up to 24 in., and for 1½, 2, and 3 in. thick covering.

Inverted Glass Bottle Type Lubricator

Providing the advantages of automatic lubrication with visibility of oil supply, the new "Glaswick" oil cup put out by the Lunkenheimer Company, Cincinnati, Ohio, consists of a steel cup with a shut-off cock in the shank and a glass bottle which fits over the top of the cup. The bottle is held securely to the cup by means of a steel wire and clamp. When placed in service the steel cup is filled with oil. The glass bottle is also filled and inverted over the steel cup. Visible presence of oil in the glass bottle is assurance that the steel cup is full and the wick is absorbing sufficient oil to insure a constant, uniform feed to the bearing.

The desired rate of feed is obtained by determining the number of strands of wick to be used, and the oil then feeds at a uniform rate without further adjustment. When replenishing the oil supply a number of spare bottles may be filled in the oil room, carried to the



Glaswick oil cup

bearings and the empties replaced with full bottles.

The cock in the shank permits shutting off the flow when the bearings are idle, making it unnecessary to remove the wicks to stop the feed.

Automatic Combustion Indicator

For applications that do not require graphic records for checkup and analysis the Hays Corporation of Michigan City, Ind., has developed the new automatic combustion indicator shown in the accompanying illustration. This instrument is designed to provide continuous indication of CO_2 only; CO_2 and furnace draft; CO_2 furnace and uptake drafts; and CO_2, furnace draft and flue gas temperature. Using the orsat principle of operation, the new instrument is similar in design to the standard Hays CO_2 recorder. The power unit for the draft attachment is the colon leather mechanism used in the company's pointer gages. The flue gas

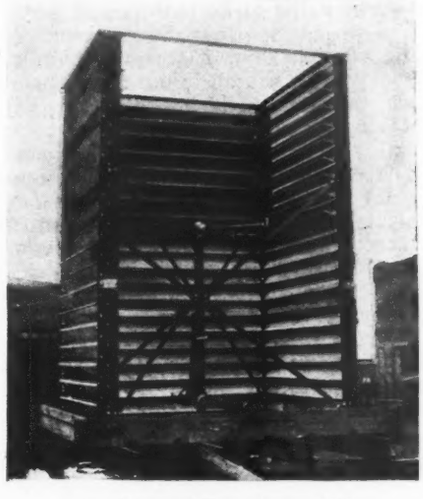
Hays automatic combustion indicator

temperature indicator, operating on the thermo-electric principle, is similar to the mechanism used in the portable combustion test.

Spray-Type Cooling Tower

In the new cooling tower designated "Nozletower" put out by Edwin Burhorn Company, West 5th St., Bayonne, N. J., the cooling is done by a spray nozzle inclosed in a framework which permits free access to the air from any direction and prevents loss of water from windage. The frame is usually about 12 ft. high and of steel, heavily galvanized by the hot-dipping process.

All four sides are fitted with louvers made of wood or metal. The upper part of the tower is fitted with V-louvers which permit the spray nozzles discharging upward without any spray having a free outlet. Much of the water is collected in the V-louvers and passes downward in the nature of a cooling tower and acts as additional cooling surface.



Burhorn cooling tower with spray nozzle

NEWS of the FIELD

New York City Board of Estimate Grants Lighting Franchise to Real Estate Company

ON THE MOTION of Mayor James J. Walker, the Board of Estimate of New York City voted a franchise on Dec. 11, which threatens to invade the virtual monopoly the New York Edison Company has had for several years in supplying electricity on Manhattan Island.

In the face of strong opposition by counsel for the Edison company the board, without a dissenting voice, voted to the Spingler Electric Corporation a franchise "to construct, maintain and operate electrical conductors for the purpose of supplying electric current for light, heat and power under West and East Thirteenth, Fourteenth and Fifteenth Streets, Fifth Avenue, University Place and Union Square West."

The Spingler corporation was formed by persons interested in the old Spingler-Van Buren estate properties in the vicinity of Union Square and is controlled by the owners of those properties. The corporation, in its petition to the board, declared that it is willing to serve all the tenants in the area covered other than their own tenants and that the latter comprise about 70 per cent of the total number of occupants of the area.

The Spingler-Van Buren Estate, from its own private generating plant, had been serving its tenants with current since 1898, but in 1917, under pressure from the Edison company, it avers, it ceased to do so, dismantled its plant and since that time has purchased current from the Edison company and submetered it to its tenants at a profit. The president of the Edison company, the petition says, has now stated his policy to be the abolition of submetering, a policy which, when adopted, would deprive the applicant of its ability to sell current to its tenants. The Spingler corporation, therefore, seeks the privilege of building its own plant and system of conduits, at an estimated cost of $300,000, and entering into competition in the Union Square section with the New York Edison Company.

Under the terms of the grant, which is for 25 years, with a 25-yr. renewal privilege, the compensation to the city will be 2 per cent of the gross receipts for the first five years, 3 per cent for the second and third years and 5 per cent for the fourth and fifth years, with a minimum sum of not less than $5,000. For the remainder of the franchise period the terms are identical with those prescribed for similar street-use grants.

Opposing the grant, Mr. Beardsley, for the Edison company, argued that the Edison company was obliged to supply with current the outlying and unremunerative sections of the city as well as the more profitable areas, and that the granting of a franchise to the Spingler concern would create a precedent that would be followed by many like applications. The result would be, he declared, that the Edison company would be deprived of much of its best territory, with the probable result that its general rates to consumers would have to be increased.

Mayor Walker retorted that if other companies should follow this precedent, provided they agreed to furnish current at rates lower than those exacted by the Edison company, it might be a blessing.

"The City Administration believes, and long has believed," said the Mayor, "that the Edison rates are too high, and we are still fighting before the Public Service Commission for their abatement."

Lignite Carbonization Plant Given First Test in Canada

FIRST FULL-SCALE TEST of the new Morfit process for the manufacture of briquettes from the lignite coal of the Estevan-Bienfait fields in southern Saskatchewan, was carried out recently at the plant of the Western Dominion Collieries, Taylorton. The new process, which was evolved at the plant, after elaborate experiments, by C. C. Morfit, a member of the New York engineering firm of Stuart, James & Cooke, is stated to be of a revolutionary nature, and is likely to have a wide influence on the industry. The Western Dominion Collieries is reported to have spent more than $2,000,000 on development work to bring the plant to its present stage of production.

In the new process the lignite coke after coming from the carbonizers is mixed with the asphalt binder in the usual way, but an improvement to the Lurgi retorts has been devised, whereby in the the third and final stage of carbonization a new method of cooling the coke is introduced. This latter process, it is stated, makes it possible to store the product, either in coke or briquette form, without danger of disintegration, crumbling or spontaneous combustion.

The process reduces the moisture content of the lignite by approximately one-third, and increases the heat value from 7,000 to about 13,000 B.t.u., which is equal to the higher-grade imported fuels.

President Gives $5,000 to Engineers' Relief Fund

PRESIDENT HOOVER has contributed $5,000 to the relief fund of the Professional Engineers' Committee on Unemployment, it was announced last week by H. deB. Parsons, general chairman. In making the gift, the President commended the work of the committee and expressed the hope that its activities might become national in scope. He said:

"The devoted effort of your committee in securing employment and relieving distress among professional engineers has my sympathetic approval. I feel that the inherent administrative ability of American engineers to meet and cope with emergencies is sufficient assurance that any funds made available to you will be well administered and used to the best advantage, not only in finding useful employment, but by relieving individual cases of distress with small loans under liberal terms, which particularly appeals to me."

All contributions received are available for relieving unemployed engineers, Mr. Parsons stated, as the overhead expenses of the committee have been underwritten by the metropolitan sections of the four founder societies.

Standard Dimensions for Flanged Valves Proposed

CENTER-TO-FACE DIMENSIONS for ferrous flanged valves, recently developed and approved by the Manufacturers Standardization Society of the Valve and Fittings Industry as standard practice, have been tentatively recommended for adoption as an American Standard by Subcommittee No. 5 of the A.S.M.E. Sectional Committee on the Standardization of Pipe Flanges and Fittings. This proposal sets forth the center-to-face dimensions of cast-iron and steel-flanged valves of the wedge gate, globe

and angle types over a considerable range of sizes and for pressures from 125 to 1,500 lb. When adopted, this standard, the subcommittee believes, should be of real value to industry as it will facilitate considerably the replacement of valves in existing piping systems.

This tentative proposal is now being distributed to a large number of interested firms and individuals for criticism and comment and after receipt of these comments the subcommittee will formulate a definite recommendation for submittal to the sectional committee.

Requests for more detailed information concerning this proposal should be addressed to C. B. LePage, assistant secretary, A.S.M.E., 29 West 39th St., New York, N. Y.

A.A.A.S. Annual Meeting In New Orleans Next Week

THE American Association for the Advancement of Science will hold its annual meeting in New Orleans, La., from Dec. 28 to Jan. 2, when fifteen of its sections as well as thirty-four scientific societies will be in session. This is the second meeting the association has held in New Orleans, the first having been held in 1905.

Of particular interest to engineers is the program of Section M, scheduled for Dec. 29 to 31, under the vice-presidency of Dexter S. Kimball, dean of engineering at Cornell University. The sessions will be held in the Municipal Auditorium and the papers to be given include: "Some Problems in Pipe-Line Transportation," T. H. Pound; "Inland Waterways," Major R. F. Fowler; "Laboratory Solution of River Problems," Lt. H. D. Vogel; "Rainfall in New Orleans and Its Removal," George Earl; and "Improving the Street Car," C. F. Hirschfeld.

At a general session on Dec. 29, the annual Josiah Williard Gibbs lecture, arranged by the American Mathematical Society, will be delivered by Dr. P. W. Bridgeman, of Harvard University, on "Statistical Mathematics and the Second Law of Thermodynamics." The Sigma Xi lecture will be given in the evening by Dr. C. F. Hirschfeld, chief of the research department of the Detroit Edison Company.

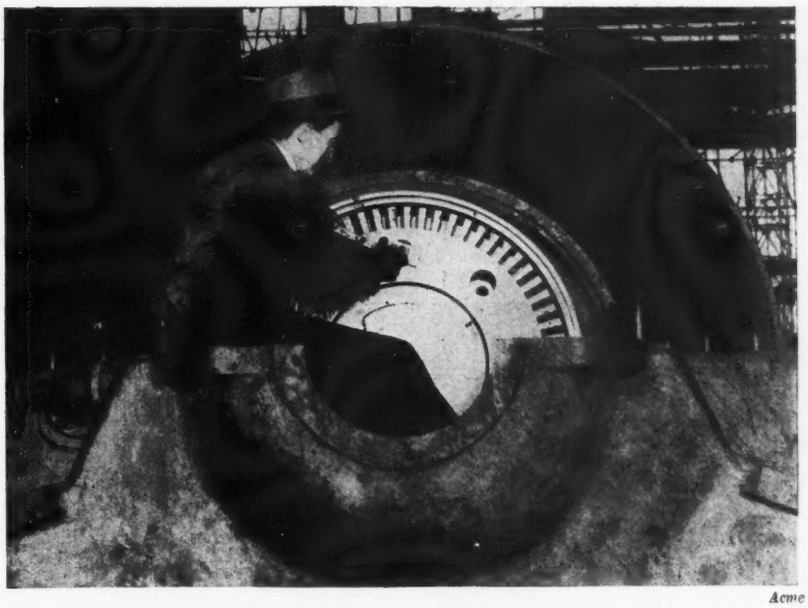
Government Still Undecided About Central Heating Plant

UNCERTAINTY still exists as to whether or not one or two central heating plants will be constructed to supply steam to the new and existing government buildings in the downtown section of Washington, according to the annual report of the Director of Public Buildings and Parks. An appropriation of $750,000 was made available during the fiscal year of 1931 for the design and construction of a west central heating plant with necessary tunnels and pipe lines to the government buildings located west of the White House grounds. These include the Navy and Munitions Building, the Interior Building, the Federal Trade Commission Building, and the State, War and Navy Building.

Preliminary designs were prepared on the assumption that the heating plant for these buildings would be exposed to view for some time. An effort was made, therefore, to design a presentable exterior structure. Ultimately, it was planned to include the heating plant in the courtyard of a permanent office building to be built around it. The general arrangement adopted was to provide four 10,000-sq.ft. and two 2,500-sq.ft. oil-fired boilers, with foundations and space to accommodate four additional 10,000-sq.ft. boilers. The original installation of 45,000 sq.ft. was intended to provide for the buildings now supplied from the existing temporary plan which must be removed. The additional 40,000-sq.ft. was intended to replace the existing boiler plants in the State, War and Navy Building and in the Interior Building.

Work on the drawings and specifications was discontinued in April, 1931, when the question was raised as to whether the West Central Heating Plant should be entirely abandoned in favor of one central plant to supply all government buildings both in the triangle area and in the section immediately west of the White House grounds. At the time work was postponed, the drawings and specifications for the west heating plant were 80 per cent completed.

INSTALLING NEW UNIT AT BATTERSEA



Acme

One of the two 65,000-kw., 1,500-r.p.m. turbine-generators being installed in the Battersea station, London, which will ultimately be increased to a capacity of 400,000 kw. These units are part of the important extension of the city's electric supply, which includes 300,000-kw. additions to the Fulham and Barking steam stations. In service next year, the Battersea units will be the largest in England

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Seattle Light Department Cuts Wages 25 Per Cent

IN AN EFFORT to make earnings meet its burden of operating costs, bond and contract obligations, the City Light Department of Seattle, Wash., has put into effect a 25 per cent reduction in the salaries of all its employees. The new wage schedule requires the City Light office staff and other inside employees, from the highest officials down, to work on a full-time basis for three-quarters of their regular pay, while outside workers on construction, maintenance and similar activities will lay off one week out of each four weeks. Linemen of the department have been rotating their work on the one-week-off-in-four basis for several weeks and all outside inspectors will be required to adopt the same system, so that all of them will be on the staggered schedule by Jan. 1.

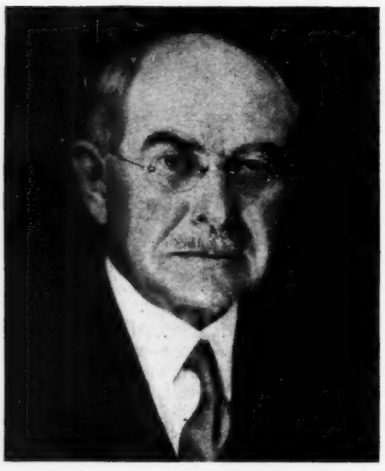
City Light faces exactly the same business conditions as other utilities, publicly and privately owned, J. D. Ross, superintendent of lighting, stated in declaring that the salary reduction was made in the interest of good management.

The department has ceased all construction work that is not absolutely necessary, Mr. Ross said, pointing out that during the last two months about 200 men working on construction were laid off and construction at Diablo was completely suspended until the resumption of better business conditions. The distribution work in the city has been cut down to the minimum necessary to care for new customers and operate the system, he stated.

Dr. E. W. Rice Awarded Edison Medal for 1931

THE EDISON MEDAL for 1931 has been awarded by the American Institute of Electrical Engineers to Dr. Edwin Wilbur, Rice, Jr., "for his contributions to the development of electrical systems and apparatus and his encouragement of scientific research in industry," it was announced Dec. 14.

Dr. Rice is past president and a



fellow of the institute and a Chevalier of the French Legion of Honor. In 1917 he was decorated by the Emperor of Japan with the Third Order of the Rising Sun with cordon. He received an honorary A.M. degree from Harvard in 1903, the degree of Sc. D. from Union College in 1906, the same degree from the University of Pennsylvania in 1924 and the degree of Doctor of Engineering from the Rensselaer Polytechnic Institute in 1917.

Dr. Rice is the inventor of the present fundamental form of high voltage oil switch and the cellular system of separating buses and circuits, as well as the application of synchronous converters to the building of unified alternating and direct current distribution systems. He was responsible for the adoption by the General Electric of the Curtis steam turbine and for the establishment of the company's research laboratory.

Number of Federal Engineers Increases 29.6% Since 1929

A SUBSTANTIAL INCREASE in the employment of professional engineers by the federal government in the face of industrial depression is disclosed by a report of a survey made public by the American Engineering Council.

"While labor conditions in many industries have been in a precarious way, the federal government has not only avoided any decrease in its wages and salaries, but has actually increased very materially the total number of employees in 34 bureaus, divisions, and independent establishments which employ engineers," says the report.

"The federal government is now employing 7,054 professional engineers in bureaus and divisions which employ over 135,000 men and women. This employment represents a very potent influence in the stabilization of employment among professional engineers."

The investigation was undertaken as a result of inquiries from engineers in all parts of the country. All federal agencies known to employ professional engineers were asked to give as of June 30 of each of the years, 1927, 1928, 1929, 1930, and 1931, the total number of engineers employed by them at that time and the total number of all employees.

A tabulation of the replies received shows that the total number of professional engineers has increased from 4,526 in 1927 to 7,054 in 1931, an increase of 55.7 per cent in five years. In terms of the depression which may be said to have begun in the fall of 1929, after the 1929 figures were complete, this tabulation shows that there were employed 5,443 professional engineers in 1929 and 7,054 in 1931, an increase of 29.6 per cent in two years.

For the same years, 1927-1931, the total number of employees in the same agencies has increased from 109,687 in 1927 to 135,765 in 1931, an increase of approximately 23.7 per cent. The increase since 1929 has been about 11.2 per cent.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

National Marine Engineers Beneficial Association. Annual convention at the Hotel Jefferson, St. Louis, Mo., Feb. 8-12. Secretary-Treasurer, Albert L. Jones, 313 Machinists' Building, Washington, D. C.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Robert H. Morse Heads Fairbanks, Morse & Co.

ACCORDING to an announcement just made public by Fairbanks, Morse & Company, Chicago, Robert H. Morse, formerly vice-chairman of the board of directors, has been elected president and general manager to succeed W. S. Hovey, who resigned on Dec. 1.

Mr. Morse was born in Chicago, Dec. 6, 1878. In 1895 he entered the employ

of the firm founded by his father, C. H. Morse, as an apprentice at the Beloit factory (then known as Fairbanks-Morse Manufacturing Company), and, except during his military service, when he was Lieutenant-Colonel in the Signal Corps, he has been with the company continuously since that time. In the thirty-six years, he has been employed in various positions as salesman, department manager, sales manager, president of the manufacturing division, vice-president in charge of purchases, first vice-president, vice-chairman of the board and now president.

G. S. Williams, Consulting Hydraulic Engineer, Dies

GARDNER STEWART WILLIAMS, 65 years old, internationally known engineer, died Dec. 12. He had been ill since last spring.

Mr. Williams long had been known as one of the leading authorities in the field of hydraulics. He served at Cornell University as professor of experimental hydraulics, 1899-1904, and was head of the hydraulics department at the University of Michigan from 1904 to 1911.

Since 1911 Mr. Williams had been a consulting engineer, specializing in hydraulics and water power. He was a member of the American Society of Mechanical Engineers and a former vice-president of the American Engineering Council and the American Society of Civil Engineers.

Personals

H. P. CHARLESWORTH, vice-president of the Bell Telephone Laboratories, New York City, has been nominated for president of the American Institute of Electrical Engineers for 1932-33 by the National Nominating Committee of the institute. Nominations for vice-presidents are: J. ALLEN JOHNSON, Buffalo, Niagara & Eastern Power Corporation; E. B. MEYER, United Engineers & Constructors, Inc., Newark; K. A. AUTY, Commonwealth Edison Company, Chicago; G. A. MILLS, Central & Southwest Utilities Company, Dallas; and C. R. HIGSON, Utah Power & Light Company, Salt Lake City. W. I. SLICHTER, of Columbia University, was nominated for national treasurer.

K. M. IRWIN, formerly mechanical engineer of the United Gas Improvement Company, Philadelphia, has been transferred to the position of assistant to the vice-president in charge of engineering for the Philadelphia Electric Company.

C. F. RADLEY, publicity director of Oakite Products, Inc., New York City, was elected president of the Exhibitors Committee Industrial and Power Shows, Inc., at the recent annual meeting of the committee's board of directors. Other officers elected are: Vice-President, VICTOR WICHUM, chief engineer of the C. J. Tagliabue Manufacturing Company, Brooklyn; Secretary, G. S. CARRICK, manager industrial department of the American Arch Company, New York; and Treasurer, J. P. FERGUSON, sales engineer of the Reading Steel Casting Company, Bridgeport.

RALPH R. CLARK has resigned from his position as power engineer of the Jackson district of the Consumers Power Company to join the Armstrong Cork Company, Lancaster, Pa., where he will be mechanical engineer in development work. Mr. Clark has been with the Consumers Power Company for the past nine years.

A. N. GEYER, who for several years has been associated with the Utah Power & Light Company, Salt Lake City, in the capacity of maintenance engineer, recently resigned that position to join the organization of the Woodward Governor Company, with headquarters at Seattle, Wash.

D. W. DEAN has been appointed manager of the control section of the industrial department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, to succeed the late W. H. MACGILLIVRAY. Mr. Dean is recognized as an authority on the design and application of steel-mill equipment. Prior to his recent appointment he was a member of the steel mill section of the company's general engineering department.

How's Business?

CURSED with its customary calendar complex, business seems bent on taking one more bellywhopper to the bottom of the hill to see how far it can go before the midnight whistles blow on Dec. 31, says *The Business Week*, Dec. 23. Almost all business indicators show intensification of the usual year-end slackness, and retail trade less than its customary seasonal stimulation. The reassuring steadiness of some key commodity prices is an almost solitary star shining among the discouraging Christmas statistics as a slight sign to the wise men that the dark days of deflation may be about ended and the New Year bring with it a more stable basis of values upon which to rebuild business.

Power production of public utilities for the week ended Dec. 12 was 1,671,717,000 kw.-hr., or 4.4 per cent below the corresponding period of 1930, according to N.E.L.A. figures.

Business Notes

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the removal of its New York office from 136 Liberty St. to the new McGraw-Hill Building at 330 West 42nd St. The new offices include a showroom and facilities for demonstrating equipment. G. N. Bull continues as district manager in New York. The company also announces that branch offices have been established in Scranton and Allentown, Pa., D. Levenson being in charge of the first and F. Shackleton covering the latter territory.

PLIBRICO JOINTLESS FIREBRICK COMPANY, Chicago, Ill., announces the appointment of the Brakel Engineering Company, 1006 Washington Ave., Houston, Tex., as its distributor in southern Texas, and the appointment of F. F. Kimball, c/o H. H. Smith Storage Company, 1015 Mulberry St., Kansas City, Mo., as its distributor in the Kansas City territory.

MAXIM SILENCER COMPANY, Hartford, Conn., has established, as an addition to its regular business, a consulting service which will specialize in the solution of noise problems. It is headed by Dr. Hiram Percy Maxim, inventor of the Maxim silencer, and will have at its disposal the services of the entire engineering and research staffs of the company.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., announces the appointment of Irving M. Day, 306 Chandler Building, Washington, D. C., as its representative in that territory. The company also announces that G. L. Simonds, Winter Haven, Fla., will represent it in the State of Florida.

AJAX FLEXIBLE COUPLING COMPANY, Westfield, N. Y., recently received an order for more than 800 flexible couplings, to be used on the conveyor drives that will be installed in the new Chicago Post Office. This is believed to be the largest order ever placed for flexible couplings on a single conveyor system.

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Trade Catalogs

SPEED CONTROLLERS—The construction, operation and applications of a complete line of variable speed transmissions is presented in illustrated Catalog No. 99, just issued by the Reeves Pulley Company, Columbus, Ind. In addition to many illustrated descriptions of the equipment itself, the catalog contains engineering data, charts and diagrams of use in planning individual installations.

REFRACTORIES—Many different types of "Carbex" refractory blocks, bricks and complete furnace settings are described and illustrated in Catalog No. 232, recently issued by the McLeod & Henry Company, Troy, N. Y. Detailed information is also given on the physical characteristics and manufacturing processes of "Carbex," the silicon-carbide refactory developed by the company.

DIESEL ENGINES—Data on 431 foreign diesel ships, together with illustrations of many recently completed liners, are contained in a new bulletin of the Busch - Sulzer Bros. - Diesel Engine Company, St. Louis, Mo. The publication also contains an article by Edward B. Pollister, president of the company, entitled "America Needs Diesel Ships."

ICE-MAKING MACHINERY—Two new bulletins on the production and uses of "FlakIce" have been issued by the FlakIce Corporation of New York, 205 Water St., Brooklyn, N. Y. Bulletin No. 8 describes and illustrates the Type AP-2708 machine, while Bulletin No. 7 covers the many applications of this new form of ice.

CONTROLLERS—The new Bristol free-vane air-operated recorder controller is described and illustrated in Catalog No. 4001, just issued by the Bristol Company, Waterbury, Conn. Full details are given on the construction and operation of these instruments, which are made in many models for recording and controlling temperatures up to 1,000 deg. F. and pressures up to 1,500 pounds.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fresno—Fresno County will receive new bids soon for construction of pumping system and pipe line at County Sanitorium. Former bids rejected.

Conn., Bridgeport—Park City Ice Co., 558 Howard Ave., awarded contract for construction of 2 story, 45 x 60 ft. ice plant to Patsy Frank Inc., 1438 Main St. Estimated cost $40,000. Maturity in spring.

Ga., Augusta—City will soon prepare plans and specifications for construction of power plant. Estimated cost $2,500,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Ill., Collinsville—City is having preliminary plans prepared for improvements to waterworks including deep well, pump house, 900 to 1,000 g.p.m. electric driven well pump, etc. Estimated cost $168,000. Kinsey Engineering Co., Marshall Bank Bldg., Pekin, is engineer.

Ill., La Salle—City plans an election in Spring to vote $550,000 bonds for construction of municipal electric light plant, including two 500 hp. boilers, two 2,000,000 kw. condensers, superheaters, turbines, etc. E. Byrne is city engineer. Burns-McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are consulting engineers.

Ind., Brazil—City is having plans prepared for construction of a municipal light plant. Estimated cost $150,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Ia., Bellevue—City will build power plant, 40 x 60 x 20 ft., with local labor, also awarded contract for two 300 hp. Diesel engines to Chicago Pneumatic Tool Co., 3655 Iron St., Chicago, Ill., in connection with extensions to light plant. Estimated total cost $60,000.

Ia., Forest City — The Lundberg Co., plans construction of a new 100 ton ice house to include refrigeration equipment.

Ia., Grand Junction—City plans election January 7 to consider construction of municipal power plant. Estimated to cost $85,000. O. V. Blaylock is city clerk.

Ia., Mason City—Jacob Decker & Sons Packing Co., awarded contract for addition to power plant including equipment to Fegles Construction Co., 711 Wesley Temple Bldg., Minneapolis, Minn. Estimated cost $375,000.

Ia., Villisca—City voted $150,000 bonds for construction of a municipal light and power plant. Edward E. Jenkins is city clerk.

Kan., Anthony—City is considering improvements to water and light plant. Black & Veatch, Mutual Bldg., Kansas City, Mo., are consulting engineers.

Kan., Manhattan — United Power & Light Corp., Arthur Groesmeck, Dist. Mgr., plans repairing undermined dam and retaining walls, etc. Estimated cost $25,000. Work will be done by owner's forces.

Kan., Oswego—City plans an election soon to vote $32,000 bonds for construction of municipal gas plant, including distribution system, etc.

Kan., Topeka — City has engaged Black & Veatch, Mutual Bldg., Kansas City, Mo., Consult. Engrs., to make a study of the pumping and electric generation capacity of municipal plant with a view of ascertaining what additional generating equipment must be installed.

La., Ruston—City, Charles G. Coyne, Mayor, having preliminary plans prepared for natural gas plant including pipe line from Monroe gas fields, also distribution system in city compressor station. Estimated cost $180,000.

Mo., Springfield—Department of Justice, Bureau of Federal Prisons, Washington, D. C., awarded contract for construction of a sewage system and pumping station to W. F. Plummer, Union National Bank Bldg., Springfield, for Hospital for Mental Delinquents here. $11,968.

Neb., Ord—City has engaged Black & Veatch, Mutual Bldg., Kansas City, Mo., Consult. Engrs., to make report outlining size and type of an addition to municipal water, power and light plant.

N. J., New Princeton—Rockefeller Institute, York Ave. and 66th St., New York, N. Y., awarded contract for construction of a laboratory building of plant and animal pathology including power house, etc., here, to Matthews Construction Co., Princeton. Estimated cost $150,000.

N. Y., Astoria—Astoria Light & Power Co., 4 Irving Pl., New York, preparing preliminary plans for addition to generator house at Winthrop Ave. and Hallet St. here. Estimated cost $25,000. J. Hunter, c/o owner, is engineer.

N. Y., Far Rockaway — Long Island R.R., Pennsylvania Station, New York, awarded contract for construction of a sub-station here to Miller Blyth, Inc., 441 Lexington Ave., New York. $15,000.

N. Y., Neponsit — Department of Hospitals, Municipal Bldg., New York, rejected bids for construction of dormitory building, power plant, laundry and altering main buildings at Neponsit Hospital here.

N. Y., Woodhull—New York Central Electric Corp., East St., Rochester, plans construction of electric light plant and distribution system here.

Okla., Fort Sill — O. W. Humphries, Constructing quartermaster, awarded contract for air corps hangar with annexes and boiler house annex to Harman Engineering Co., 844 North Rush St., Chicago, Ill. $55,370.

Texas — Phillips Petroleum Co., Bartlesville, Okla., plans additional stations and increasing capacity of present pumping stations on pipe line extending from Borger, Tex. Private plans. Machinery and equipment will be required.

Tex., Berger—City awarded contract for construction of a natural gas plant including booster plant, distribution system, etc., to Joseph A. Greenspon & Sons, 3133 North Hall St., St. Louis, Mo. $125,000.

Va., Blacksburg — Town, F. W. Earhart, Mayor, plans addition to water supply including pumping plant, pipe line, etc. Estimated cost $85,000. Palmer St. Clair, Jr., Roanoke, is engineer.

Wis., Manitowoc — County of Manitowoc, A. W. Tetzloff, Clk., will soon award contract for construction of a refrigeration plant, cold storage rooms, and equipment at County Sanitarium. W. J. Raueber, Manitowoc, is engineer.

Ont., St. Catharines — St. Catharines Cold Storage Co., Davidson St., plans construction of a pre-cooling, central packing and cold storage plant. Estimated cost $100,000.

Equipment Wanted

Air Compressor—Mankato, Minn.—City, F. D. Bates, Clk., will soon receive new bids for portable air compressor. Former bids rejected.

Electrical Equipment—Philadelphia, Pa.—Department of City Transit, C. E. Myers, Dir., City Hall, will receive bids until December 29 for furnishing, installing and relocating electrical equipment in substations and subway. Cont. 220.

Engines—Crown Point, Ind.—City plans to discontinue Utility Co. power in waterworks department and install Diesel engines to run pumps.

Hoisting Engine—U. S. Engineer, asks bid in January for a steam hoisting engine; 22 additional hoists may be ordered within 60 days. If you want details address Power.

Pumps, etc.—Oregon, Wis.—State Board of Regents, A. W. Bayley, Secy., Madison, will receive bids until December 28 for deep well turbine pump, sludge pump, dry chemical feeders, etc., in connection with proposed water softening and pumping plant at State Industrial School.

Switchboard and Generator—Two Rivers, Wis.—City, E. J. Connelly, Mgr., will soon receive bids for 5 panel switchboard and generator.

Industrial Projects

Calif., Stockton—Pacific Gas & Electric Co., 245 Market St., San Francisco, awarded contract for construction of a 1 story meter shop here, to E. H. Riley, First National Bank Bldg., Stockton. $45,000.

Illinois and Missouri—Marquette Cement Co., plans additions and alterations to cement plants at La Salle, Ill., and Cape Girardeau, Mo. Estimated cost to exceed $40,000 each. Maturity indefinite.

Ind., Evansville — Mead-Johnson Co., 200 South St. Joseph Ave., awarded contract for construction of a factory at Ohio and St. Joseph Sts., to M. J. Hoffman Construction Co., 20 N. W. 4th St. Estimated cost $40,000.

Mass., Boston — Skinner Organ Co., Boston, and Aeolian Co., 5th Ave. and 54th St., New York, plan alterations to organ and piano manufacturing plant here. Estimated cost to exceed $40,000 including equipment. Work will be done by day labor and separate contracts.

N. J., Carlstadt (br. Rutherford) — Plastic Art Marble Co., 321 11th St., will soon award contract for construction of a 2 story factory on 14th St. Estimated cost $40,000. J. Thomas Camlet, 26 Piaget Ave., Clifton, is architect.

N. J., Millville—Millville Hosiery Co., awarded contract for a 1 story, 107 x 122 ft. hosiery mill to George Kessler Co., 1733 North Marvine St., Philadelphia, Pa. Estimated cost $40,000.

N. J., Newark—Owner, c/o Alfred Peter, 207 Market St., Archt., will soon award contract for construction of a 2 story refinery plant. Estimated cost $40,000.

N. Y., Buffalo — Westinghouse Electric & Mfg. Co., Elliott Sq., awarded contract for construction of a 2 story, 112 x 390 ft. manufacturing building and warehouse, to John W. Cowper Co. Inc., Rand Bldg.

O., Ravenna — Cleveland Worsted Mills Co., 6114 Broadway, Cleveland, awarded contract for construction of a 1 story factory to P. L. Frank Construction Co., Ravenna. Estimated cost $40,000.

Tex., Tahoka—Continental Chemical Co., c/o P. J. McIntosh, Gen. Mgr., Thomas Bldg., Dallas, will award contract at once for construction of a group of buildings, including evaporating building, pumping equipment, etc., near here. Estimated cost $1,600,000. W. D. Alt, 301-D Thomas Bldg., Dallas, is engineer.

B. C., New Westminster—Swift Canadian Co. Ltd., 17 Water St., Vancouver, is receiving bids for construction of extensive additions to packing plant here. Plans include 40 x 60 ft. boiler house, hog fuel shed, refinery building and new smokestack. Estimated total cost $60,000.

N. B., St. John—Federated Oil & Refineries Ltd., plans initial plant to cost $100,000.

Ont., Kitchener—Huether Brewing Co., W. Renaud, Mgr., King St. W., will soon start work on 4 story, 40 x 50 ft. addition to brewery, including malt mill, mash tubs, brew kettles, cooling room and beer tanks. Estimated cost $50,000. W. H. Schmalz, 129 King St. W., is architect. Equipment will be installed.

Ont., Sarnia—Perkins Bakery Co., Saginaw, Mich., manufacturers of bakery and confectionery machinery, plans construction of a plant here. Equipment will be required.

Ont., Toronto — Planet Mfg. Co. Ltd., C. Havelock Taylor, Pres., manufacturers of cylinder grinders, plans construction of a plant. Estimated cost $50,000.